Perugia, Italy July 2-13, 2007

IAGA

INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY

ASSOCIATION SYMPOSIA AND WORKSHOPS

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IUGG XXIV 2007 PERUGIA ITALY

EARTH: OUR CHANGING PLANET

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Abbreviations

IAG	International Association of Geodesy
IAGA	International Association of Geomagnetism and Aeronomy
IAHS	International Association of Hydrological Sciences
IAMAS	International Association of Meteorology and Atmospheric Sciences
IAPSO	International Association for the Physical Sciences of the Oceans
IASPEI	International Association of Seismology and Physics of the Earth's Interior
IAVCEI	International Association of Volcanology and Chemistry of the Earth's Interior
CliC	Climate and Cryosphere
Ev-K2-CNR	Everest-K2 CNR Committee
GEWEX	Global Energy and Water Experiment
HKH-FRIEND	Hindu Kush-Himalayan Flow Regimes from International Experimental and Network Data
IABO	International Association for Biological Oceanography
IACS	International Association of Cryospheric Sciences
ICACGP	International Commission on Atmospheric Chemistry and Global Pollution
ICASVR	International Commission on Atmosphere-Soil-Vegetation Relations
ICCE	International Commission on Continental Erosion
ICCL	International Commission on Climate
ICCLAS	International Commission on the Coupled Land-Atmosphere System
ICCP	International Commission on Clouds and Precipitation
ICDM	International Commission on Dynamic Meteorology
ICGW	International Commission on Groundwater
ICIMOD	International Center for Integrated Mountain Development
ICMA	International Commission on the Middle Atmosphere
ICRS	International Celestial Reference System
ICSIH	International Commission on Snow and Ice Hydrology
ICSW	International Commission on Surface Water
ICT	International Commission on Trac
ICWQ	International Commission on Water Quality
ICWRS	International Commission on Water Resources Systems
IGAC	International Global Atmospheric Chemistry
IGS	International Glaciological Society
ILP	International Lithosphere Program
INQUA	International Union for Quaternary Research
ION	International Ocean Network

IRC	International Radiation Commission
PUB	Prediction in Ungauged Basins
SCAR	Scientific Committee on Antartic Research
SEDI	Study of the Earth's Deep Interior
SPARC	Stratospheric Processes and their Role in Climate
UCCS	Union Commission for the Cryospheric Sciences
UNESCO	United Nation Educational, Scienti. c and Cultural Organization
UNITAR	United Nations Institute for Training and Research
WMO	World Meteorological Organization

Session code naming

The first letter of the session codes indicates whether the session is a Union, a Joint Interassociation or a single Association sponsored event, the second letter indicates the type of event: Symposium (S) or Workshop (W). For Joint events, the second letter indicates the Lead Association (with the abbreviations listed below) and the third indicates whether a session is a Symposium (S) or a Workshop (W). In some cases (namely IAGA, IAHS) Association session codes have an extra codi. cation referring to a speci. c Theme or Division.

U	UNION
J	JOINT
G	IAG
A	IAGA
H	IAHS
M	IAMAS
P	IAPSO
S	IASPEI
V	IAVCEI

Some examples:

US002

is a **U**nion **S**ymposium; **JGW**001 is a **J**oint IA**G** **W**orkshop with IAG as the Lead Association;

MS003

is an Association (IA**M**AS) **S**ymposium. **AS III** 020 is an Association (IAG**A**) **S**ymposium sponsored by its **III** Division.

ASI001 **Symposium** **(2994 - 3029)**

Convener : Dr. Johannes Wicht
Co-Convener : Dr. Arnaud Chulliat, Dr. David Ivers

Planetary Dynamos: theory, models, observation and experiment

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ASI002 **Symposium** **(3030 - 3047)**

Convener : Prof. Erwin Appel, Dr. Silvana Geuna
Co-Convener : Mrs. Otofuji Yo-Ichiro

Paleomagnetism and geodynamics neotectonics, continental reconstruction, reference frames

---

ASI003 **Symposium** **(3048 - 3067)**

Convener : Dr. Cathy Batt
Co-Convener : Dr. Elisabeth Schnepp

Magnetic dating on all time scales

ASI004 **Symposium** **(3068 - 3082)**

Convener : Mr. Yongjae Yu, Dr. Yuhji Yamamoto
Co-Convener : Dr. David Krasa

Palaeointensity studies progress and challenges

ASI005 **Symposium** **(3083 - 3103)**

Convener : Dr. Fatima Martin Hernandez

Magnetic anisotropy different scales, different parameters, different stories?

ASI006 **Symposium** **(3104 - 3115)**

Convener : Dr. Richard Elmore
Co-Convener : Dr. David Heslop, Dr. Leonardo Sagnotti

Acquisition and stability of natural and laboratory-produced remanence

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ASI007 **Symposium** **(3116 - 3134)**

Convener : Dr. Ann Hirt
Co-Convener : Dr. Monika Hanesch

Magnetic signature of past and present environmental changes

ASI008 **Symposium** **(3135 - 3141)**

Convener : Mr. Tomas Kohout

Magnetism of extraterrestrial materials and bodies

ASI009 **Symposium** **(3142 - 3158)**

Convener : Dr. Ramon Egli
Co-Convener : Dr. Eduard Petrovsky

Progress in palaeo- and rock-magnetic methodologies

ASI010 **Symposium** **(3159 - 3172)**

Convener : Prof. Helga De Wall
Co-Convener : Dr. Tomasz Werner

Open Poster Session

ASI011 **Symposium** **(3173 - 3200)**

Convener : Dr. Maxwell Meju
Co-Convener : Dr. Claudia Mabel Sainato, Prof. Gad El-Qady

Environmental studies

ASII012 **Symposium** **(3201 - 3217)**

Convener : Dr. Anasuya Aruliah
Co-Convener : Prof. David Hysell

Small- and meso-scale structure in the thermosphere and ionosphere: observations and modeling

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ASII013 **Symposium** **(3218 - 3223)**

Convener : Prof. Alan Aylward
Co-Convener : Prof. Lie Zhu, Dr. Balan Nanan

Response of the ionosphere-thermosphere to large geomagnetic storms: data availability and modeling

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ASII015 **Symposium** **(3224 - 3245)**

Convener : Prof. C. Robert Clauer
Co-Convener : Dr. Kirsti Kauristie, Dr. Mervyn Freeman

Conjugate and interhemispheric polar studies (Division II and III)

ASII016 **Symposium** **(3246 - 3261)**

Convener : Dr. Ludger Scherliess
Co-Convener : Dr. Tomoko Matsuo

Data assimilation and space weather (Division II, III and IV)

ASII017 **Symposium** **(3262 - 3306)**

Convener : Dr. Janet Kozyra

Sun-Earth system: science and impacts (Divisions II, III and IV)

ASIII018 **Symposium** **(3307 - 3345)**

Convener : Dr. Christopher Owen

Magnetopause and magnetosheath processes: reconnection, diffusion and boundary dynamics (Divisions III and IV)

ASIII019 **Symposium** **(3346 - 3384)**

Convener : Dr. Vassilis Angelopoulos
Co-Convener : Prof. Wolfgang Baumjohann

Progressing to closure in magnetotail plasma sheet and substorm processes

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ASIII020 **Symposium** **(3385 - 3441)**

Convener : Prof. William Lotko

Magnetosphere-ionosphere interactions and auroral processes (Divisions III and II)

ASIII021 **Symposium** **(3442 - 3487)**

Convener : Prof. Tuija Pulkkinen

Geomagnetic storms: toward a coupled system level understanding (Divisions III and II)

ASIII022 **Symposium** **(3488 - 3505)**

Convener : Dr. Stefan Eriksson
Co-Convener : Dr. Jesper Gjerloev

Perspectives from global models and synoptic observations (Divisions III and II)

ASIII023 **Symposium** **(3506 - 3522)**

Convener : Dr. Larry Lyons
Co-Convener : Dr. Sorin Zaharia

Causes and evolution of plasma pressure distributions

ASIII025 **Symposium** **(3523 - 3541)**

Convener : Dr. Alain Hilgers
Co-Convener : Prof. Hermann Luhr

Techniques and instrumentation in space plasma physics

ASIII026 **Symposium** **(3542 - 3580)**

Convener : Prof. Anthony Chan

Wave and particle dynamics in the ring current and radiation belts

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ASIII027 **Symposium** **(3581 - 3611)**

Convener : Dr. Pontus Brandt
Co-Convener : Dr. Emma Bunce

Other magnetospheric worlds and planetary ionospheres and thermospheres (ASII014 merged with this symposium)

ASIII028 **Symposium** **(3612 - 3619)**

Convener : Prof. Masaki Fujimoto

Reporter reviews

ASIV029 **Symposium** **(3620 - 3626)**

Convener : Dr. Ed Cliver

The International Geophysical Year and its impact on space science (Division IV and IDCH, Divisions II, III and V)

ASIV030 **Symposium** **(3627 - 3670)**

Convener : Dr. Mari Paz Miralles
Co-Convener : Dr. Jorge Sanchez Almeida

New results from solar and heliospheric missions

ASIV031 **Symposium** **(3671 - 3701)**

Convener : Prof. Gary Zank

From micro- to macro-scales in the heliosphere and magnetospheres (Divisions IV, II, and III)

ASIV032 **Symposium** **(3702 - 3729)**

Convener : Dr. Joseph Davila

IHY and universal processes (Divisions IV, II, and III)

ASIV033 **Symposium** **(3730 - 3743)**

Convener : Dr. Christian Mazelle

Neutral-plasma interactions for planets, moons, asteroids, and comets

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ASIV034 **Symposium** **(3744 - 3747)**

Convener : Prof. Iver Cairns

Reporter Reviews

ASV035 **Symposium** **(3748 - 3791)**

Convener : Dr. Jean-Jacques Schott
Co-Convener : Dr. Pieter Kotze

The role of magnetic observatories in monitoring and modeling Earths magnetic field

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ASV036 **Symposium** **(3792 - 3812)**

Convener : Dr. Baldev Arora
Co-Convener : Dr. Angelo De Santis, Dr. Enkelejda Qamili

Geomagnetic measurements in remote regions (Division V and ICDC)

ASV037 **Symposium** **(3813 - 3844)**

Convener : Dr. Eigil Friis-Christensen
Co-Convener : Dr. Vincent Lesur, Dr. Stefan Maus

International Decade of Geopotential Field Research: Current achievements and expected impact of Swarm (Divisions V, and I, II, III)

ASV038 **Symposium** **(3845 - 3862)**

Convener : Prof. Dhananjay Ravat
Co-Convener : Mr. Juha Korhonen, Dr. Erwan Thebault

World Digital Magnetic Anomaly Map

ASV039 **Symposium** **(3863 - 3912)**

Convener : Dr. Juan Jos Curto
Co-Convener : Dr. Renata Lukianova, Prof. Kalevi Mursula

Use of geomagnetic data and indices in space weather and space climatology

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ASV040 **Symposium** **(3913 - 3920)**

Convener : Prof. Toshihiko Iyemori

Division V Reporter Reviews

ASICDC041 **Symposium** **(3921 - 3934)**

Convener : Dr. Baldev Arora, Prof. Nguyen Thi Kim Thoa

The investigation of low-latitude and equatorial geomagnetic variations since the International Geophysical Year 1957

ASICDC042 **Symposium** **(3935 - 3951)**

Convener : Dr. Polinaya Muralikrishna

Advances in the investigation of equatorial aeronomic processes since the International Geophysical Year 1957

ASIDCH043 **Symposium** **(3952 - 3976)**

Convener : Dr. Gregory A. Good, Dr. Ed Cliver

The International Geophysical Year: A 50-yr Retrospective

(A) - IAG - *International Association of Geodesy*

ASI001 **2994 - 3029**

Symposium
Planetary Dynamos: theory, models, observation and experiment

Convener : Dr. Johannes Wicht
Co-Convener : Dr. Arnaud Chulliat, Dr. David Ivers

The field of planetary magnetism is presently in a state of flux due to a broad array of new scientific inputs. Ongoing satellite observations by rsted, CHAMP, and SAC-C are making measurements of Earths magnetic field with previously unknown precision. In the past decade, new models of the historic geomagnetic field have been improved to accurately extend back nearly 10,000 years in time, requiring explanations of core dynamics on longer timescales. Missions to other planets, such as the Galileo, Cassini and the MGS missions, have discovered a broad array of magnetic field morphologies and magnetic histories within our solar system. Numerical dynamo models and advanced laboratory experiments are both accessing increasingly realistic nearly-planetary parameter regimes and are offering new ways to explain the observations. These diverse ongoing efforts offer a formidable chance to advance our understanding of how planets generate large-scale magnetic fields. In this session, we invite contributions relating to this joint effort

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ASI001 **Oral Presentation** **2994**

Experimental and numerical studies of convection and magnetoconvection in a rapidly rotating spherical shell.

Dr. Nicolas Gillet
Institute of Geophysics and Tectonics University of Leeds IAGA

Thermal convection in a rapidly rotating spherical shell is investigated experimentally and numerically. The experiments are performed in water (Prandtl number, $P=7$) and in gallium ($P=0.025$), at Rayleigh numbers R up to 80 times critical in water (up to 6 times critical in gallium) and at Ekman numbers $E sim 10^{-6}$. The measurements of fluid velocities by ultrasonic Doppler velocimetry are quantitatively compared with quasi-geostrophic numerical simulations incorporating a varying $beta$--effect and Ekman pumping. In water, unsteady multiple zonal jets, weaker in amplitude than the non axisymmetric flow, are experimentally observed and numerically reproduced at moderate forcings ($R/R_c < 40$). In this regime, zonal flows and vortices share the same length-scale. Gallium experiments and strongly supercritical convection experiments in water correspond to another regime. In these turbulent flows, the zonal motions amplitude $overline{U}$ dominate the non-axisymmetric motions amplitude $widetilde{U}$. As a result of the reverse cascade of kinetic energy, the characteristic Rhines length-scale $ell_{beta} sim sqrt{overline{U}/beta}$ of zonal jets emerges, and the boundary friction becomes the main brake to the growth of the zonal flow. A scaling law $overline{U}sim widetilde{U}^{4/3}$ is then derived and verified both numerically and experimentally. We study the addition of a z-invariant toroidal magnetic field on the fluid flow. We demonstrate a stabilising effect of the magnetic field in the weak-field case, characterised by an Elsasser number $Lambda < (E/P)^{1/3}$. We find that it is explained by the changes of the critical parameters at the onset of convection as $Lambda$ increases. Like in the non-magnetic study, strong zonal jets of characteristic Rhines length-scales dominate the fluid dynamics. A new characteristic of the magnetoconvective flow is the elongation of the convective cells in the direction of the imposed magnetic field, introducing a disctinct azimuthal length-scale ell_{phi}. Combining experimental and numerical results, we derive the scaling law $overline{U} sim widetilde{U}^{4/3} left(ell_{phi}/ell_{beta} right)^{2/3}$ in the case where anisotropy enters the system.

Keywords: magnetoconvection, experiments, quasi geostrophic

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ASI001 **Oral Presentation** **2995**

Inverse dynamo problem in a cylinder

Dr. Jan Simkanin
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Andreas Tilgner

The geomagnetic field is (according to current knowledge) generated by Geodynamo (a hydromagnetic dynamo) action in the outer Earth's core. For simplicity, it can be divided into its poloidal and toroidal components. Toroidal component of geomagnetic field is confined to the Earth's core and we cannot observe it. The outer Earth's core is surrounded by the electrically very slightly conductive region - Earth's mantle, in consequence of it the toroidal field is shielded. Thus, an information about the toroidal field is available only indirectly - it is necessary to solve an inverse problem. The so-called invisible dynamo problem belongs to the group of the inverse problems. The invisible dynamo problem gives possibility to tell us whether any hydromagnetic dynamo exists which produces invisible magnetic field (a magnetic field confined in the area of its generation which does not penetrate the surroundings and remains invisible for any observer in the surrounding area). The investigations of the invisible dynamos in the cylinder showed that an invisible magnetic field exists ("an invisible solution") but this magnetic field decays - no dynamo action (no growing field has been found). Consequently, this problem is still open. A working invisible dynamo was found only in the sphere as a mode of $alpha^{2}$ mean field dynamo. The inverse dynamo problem asks for a velocity field given a magnetic field observed in the vacuum region surrounding the conducting fluid, such that the magnetic field is maintained by a dynamo process. Solutions to the inverse dynamo are presumably not unique, but no example seems to be known of two velocity fields producing the exact same magnetic field in the vacuum region. Looking for the such flows which produce the same external magnetic field, is our main goal. The problem is solved again in a cylinder. The results showed that a solution exists, i.e. we have found such flows (modes of a kinematic dynamo) in a cylinder, which lead to the identical external magnetic fields (outside of the cylinder). Even though only a relatively small interval of occurence of such flows has been found, there are certainly many other solutions for different velocity profiles. Nonetheless, an exterior magnetic field probably strongly restricts the possible velocity fields that have generated it.

Keywords: inverse dynamo problem, invisible dynamo problem, helical flows

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ASI001 **Oral Presentation** **2996**

Noise induced relaxation oscillations and Earth's magnetic field reversals

Dr. Frank Stefani
MHD Department Forschungszentrum Dresden Rossendorf

Gunter Gerbeth, Uwe Guenther, Mingtian Xu, Luca Sorriso-Valvo

The magnetic field of the Earth is known to undergo polarity reversals with a mean reversal rate that varies between zero during the superchrons and around 5 per Myr in the present. Typically, these reversals have an asymmetric, saw-toothed shape with a slow decay and a fast recreation of the dipole. This asymmetry points to a possible connection with relaxation oscillations as they are well known from the van der Pol oscillator. A simple mean-field dynamo model with a spherically symmetric helical turbulence parameter which is quenched by the magnetic energy and disturbed by additional noise [1] is analysed with view on this similarity. The basic features of geomagnetic polarity reversals are shown to be generic consequences of the dynamo action in the vicinity of branching points of the spectrum of the dynamo operator where two real eigenvalues coalesce and continue as a complex conjugated pair of eigenvalues. A comparison of the time series and the phase space trajectories with those of paleomagnetic measurements is carried out. For the case of highly supercritical dynamos a very good agreement with the paleomagnetic data is achieved [2]. We explain also why such highly supercritical dynamos have a general tendency to self-tune into reversal prone states [3]. The similar clustering properties of numerical and paleomagnetic reversal sequences are discussed. Spectral theory of the non-selfadjoint dynamo operator is also invoked to speculate that the growth of the inner core might be responsible for the long term changes of the reversal rate and for the occurrence of superchrons. [1] F. Stefani and G. Gerbeth, Phys. Rev. Lett. 94 (2005), 184506 [2] F. Stefani et al., Geophys. Astrophys. Fluid Dyn., submitted; arxiv.org/physics/0701026 [3] F. Stefani et al., Earth Planet. Sci. Lett. 143 (2006), 828-840

Keywords: dynamo, reversals

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ASI001 **Oral Presentation** **2997**

A feedback dynamo generating Mercury's magnetic field

Prof. Karl-Heinz Glassmeier
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Hans-Ulrich Auster

Planet Mercury has a global magnetic field of internal origin. Its low intensity, of the order of 340 nT at the surface, indicates that the Hermean dynamo is special as much stronger fields are to be expected for a conventional dynamo operating in Mercurys core. Here we suggest a feedback dynamo model where the Hermean dynamo is embedded in an external field which is generated by the Chapman-Ferraro current of the small magnetosphere generated by the internal field of Mercury. This self-generated ambient field has a pronounced influence on the dynamo action. Based on a simple kinetic α-ω-dynamo model we demonstrated that the suggested feedback dynamo has two solutions, a weak field and a strong field solution. The weak field solution is that one where the external field opposes dynamo action, while the strong field solution leads to Earth-like solutions

Keywords: planetary dynamo, mercury, magnetosphere

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ASI001 **Oral Presentation** **2998**

Spatial-temporal structure of the geomagnetic field dynamics.

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Russian Academy of Science IZMIRAN IAGA

Tatiana Bondar, Vadim Golovkov

Interaction of Archimedean, Coriolis and magnetic forces produce the complete motion system in the earth liquid core which is able to generate and support its magnetic field. The necessary condition of generation is the developed turbulence in the intercore motions. The common characteristic of any turbulence is its hierarchical structure. In the earth liquid core cell sizes vary from the whole core size to minimal ones, which defined by equality of the field generating in a cell with its dissipation. A relatively low conductivity of the mantle allows fields produced by sources with different sizes and different characteristic times to be observed on the earth surface. So, the spatial-temporal models of the geomagnetic field reflect the structure of intercore motions at least within the upper layers of the liquid core. A precise model of the field were developed for time interval from the end of XIX century to the beginning of the XXI one (Golovkov et al., 2006). To estimate intercore motions this model was divided into parts with different spatial-temporal characteristics by the Natural Orthogonal Components Technique. The interaction of these part was studied in detail. It is shown that the secular variations for this time interval are divided into trend variations the characteristic sizes of which correspond the sizes of world anomalies and into decade ones with characteristic times of about several decades. The last type of variations has no direct connection with the field structure. Their foci arise and decay casually mainly in at middle latitudes. It is revealed that jerks play role of precoursors for decade secular variations. It is also shown that a westward drift of the geomagnetic field is not a global phenomenon but is provided by westward displacement of an isolated structure of the main geomagnetic field. This structure has dimensions of a global anomaly and should be associated with well known Brazil anomaly. It is noted that for the whole time interval including the beginning of XXI century provided with satellite surveys, the ratio R1/R2 of the spatial power spectrum uniformly decreases. Reference: T.N. Bondar, V.P. Golovkov and S.V. Yakovleva. The Geomagnetic Field in the 20th Century. Geomag. & Geoel., v.46, 3, p.389-402, 2006.

Keywords: intercore motions, spatial temporal models, westward drift

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ASI001 **Oral Presentation** **2999**

An investigation of geomagnetic reversal mechanisms

Dr. Jon Rotvig
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The first systematic study of geomagnetic reversals in numerical dynamos appeared only recently, Kutzner and Christensen (2002). They find that a necessary condition for obtaining solutions displaying reversals is a sufficiently weak Lorentz force relatively to the other forces. In addition, the driving of the system must be sufficiently strong. Although this scheme is different from the Glatzmaier-Roberts scenario, it has been shown robust to a variety of driving mechanisms. In the present work, we filter out the flow in the magnetic induction term, i.e., the advection and stretching of magnetic field lines, in small regions of the liquid shell in an attempt to identify processes responsible for triggering reversals or stabilizing the dipole. In addition, we identify regions important to the overall dynamo action and determine flow components that affect the saturation of the magnetic energy below the kinetic energy. The rapid rotation of the spherical shell introduces regions that to some extent have disconnected fluid dynamics. As long as the driving is not too strong the tangent cylinder (TC) separates the dynamics. Based on results obtained in a highly supercritical 2.5D model, Sarson and Jones (1999) suggested that rising plumes inside the TC may act as reversal triggers. However, as we have shown recently, there is no direct correlation between the onset of reversals and the onset of convection inside the TC. Nevertheless, the reversals are being shut down by filtering out the flow in the induction term in a narrow band at mid-radius inside the TC. The same applies very efficiently to a narrow equatorial region immediately outside the TC (the effects of the flow components in the remaining part of the equatorial plane have also been determined, but they are more complex). It is the combined effect of these regions that is causing the reversals (given the imposed driving mechanism). Several other regions of filtering do not affect the existence of reversals. Finally, magnetic induction close to the CMB seems to decrease the reversal frequency and it adds noise to the dipole position.

Keywords: geodynamo, reversals, simulations

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ASI001 **Oral Presentation** **3000**

Boundary-locked dynamos with weakly convecting outer regions

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We look at convection-driven dynamos with reduced or inward heat flux at the outer boundary. As convection in the outer regions of the fluid shell is suppressed, the dipolar structure of the magnetic field becomes more pronounced. However, increasing the Rayleigh number gives a regime where convection is strong inside the tangent cylinder, but weak near the outer boundary. We show that dynamos with a weakly convecting top layer support locking of the flow and magnetic field to lateral inhomogeneities at the boundary, when the thermal and magnetic diffusivities are of the same magnitude. On the other hand, vigorous convection in the outer regions of the fluid core has a detrimental effect on locking of dipolar structures. In such models, strong thermal diffusion is required to influence the core flow and produce locking.

Keywords: geodynamo, locking, inhomogeneity

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ASI001 **Oral Presentation** **3001**

Dynamical Regimes and Energy Budgets in Planetary Dynamos

Prof. Chris Jones
Department of Applied Mathematics University of Leeds IAGA

Dr Binod Sreenivasan

The first numerical simulations of the geodynamo and other planetary dynamos were restricted to a very limited parameter regime, so that it was not easy to understand the physical processes involved in dynamo generation, and estimate their length-scales and time-scales. It is now possible to extend the domain of parameter space and hence begin to explore the physical mechanisms and dynamical regimes that can occur in convection-driven rapidly rotating dynamos. At the rather small Ekman numbers and moderate Rayleigh numbers now achievable, the resulting flows are strongly turbulent. Under these circumstances the inertial theory of rapidly rotating convection suggests that the Rhines scale replaces the linear critical wavelength as the dominant length-scale of convection rolls. However, in planetary dynamos the Lorentz forces are important, and a magnetic length scale derived from the ohmic decay time and the magnetic diffusivity becomes significant. In planetary cores, this length scale is larger than the Rhines scale, whereas in simulations the magnetic length scale is similar to the Rhines scale. The dynamical regime can be different depending on the ratio of these length scales, and this may affect the relative magnitude of ohmic and viscous dissipation. A related issue is the relative magnitude of the inertial terms in the equation of motion compared to the other terms in that equation. The various different dynamical regimes are associated with different scaling laws for typical velocity and magnetic field strength, so these issues are important when numerical simulations are extrapolated to actual planetary dynamos. The enhanced understanding of dynamo processes is making it possible to relate the strength and morphology of magnetic fields to the heat flux coming out of the planets. This enables us to use magnetic data to constrain the thermal history of the planets, which relates to issues such as the age of the Earth's inner core. The thermal history is crucial to understanding which planets have active dynamos and which have extinct dynamos, so information from numerical simulations may at last lead to some understanding of the remarkable diversity of planetary magnetic fields.

Keywords: planets, dynamos

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ASI001 **Oral Presentation** **3002**

Constraints on differential rotation and magnetic field in 3D simulations of giant planets

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Three-dimensional simulations of convection and magnetic field in giant planets, like Jupiter and Saturn, can be constrained by the pattern and amplitude of the observed heat flow, differential rotation and magnetic field at the planet's surface and by the radial profiles of the mean temperature, density and pressure below the surface obtained from one-dimensional evolutionary models. However, because of computational limitations, 3D simulations are forced to use turbulent (enhanced) values of viscous and thermal diffusivities. Therefore, in order to maintain a realistic surface differential rotation and depth-dependent convective velocity amplitudes, a larger than realistic diffusive heat flow at the surface is needed in the models to drive convection against the enhanced viscosity. However, a realistic magnetic diffusivity that increases exponentially with radius in the semi-conducting region can be employed in these simulations. Therefore ohmic heating computed with the simulated 3D electric currents and magnetic fields can be compared to the actual (smaller) observed surface heat flow to provide constraints on the possible patterns and amplitudes of the differential rotation, convection and magnetic field deep within the interiors of giant gas planets.

Keywords: 3d simulations, giant planet dynamo, differential rotation

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ASI001 **Oral Presentation** **3003**

Modeling of the helical turbulence

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Bernhard Steffen

The modern geodynamo models can reproduce various features of the observable geomagnetic field. However, the fine structure of the rapidly rotating MHD turbulence in the liquid core is still very unclear, but it should be taken into account in LES simulations . Therefore it is not surprising that a similar morphology of the magnetic field in the models can be obtained using quite different dynamo models with different field generation mechanisms. In some sense geodynamo modeling is an ill-posed problem. We emphasize, that energy and other MHD integrals can be quite large at the small (invisible) scales (at least for some range of parameters) and should be analyzed in details. Here we present a modeling of the simple Boussinesq convection in a periodic box with and without magnetic field. We show how scaling laws of the fields and helicities depend on heating and rotation. We also consider the fluxes of these quantities in wave space, which depending on the relative strength of rotation and buoyancy can go from large to small or from small to large scales.

Keywords: cascade processes, energy transfer, helicity quenching

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ASI001 **Oral Presentation** **3004**

The magnetic structure of numerical dynamos

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The numerical models for the generation of the Earth's magnetic field operate in a parameter range which is very remote from typical planetary core values. Most importantly, the ratios between thermal, chemical, viscous and magnetic diffusivities are not well simulated. This raises questions regarding the relevance of the model outputs, although they usually show a good level of similarity with the geomagnetic data. This general criticism has been recently challenged by results from a scaling analysis, showing that the saturation amplitude of the velocity and magnetic fields are weakly or not diffusivity-dependent. Using a new fieldline-based dynamical imaging technique, we re-visit the dynamo saturation mechanisms in light of time-dependant visualizations of the inner magnetic structure. The technique is a representation of magnetic fieldlines accounting for the local energy that they carry, together with an algorithm for the time evolution of anchor points. In reasonably Earth-like numerical dynamo models, the dynamical fieldline imaging highlights three types of magnetic structures, which are reminiscent of, but, owing to Lenz's law, distinct from flow structures: the magnetic cyclones (MCs), anticyclones (MAs) and upwelling plumes (MUs). MAs are responsible for the regeneration of the large-scale dipole. MCs are important for the saturation of the dynamo through Ohmic dissipation in a local magnetostrophic balance. For the first time, we present a fieldline-based mechanism for excursions and reversals of the dipole axis, and highlight the essential role of MUs in the production of these events. Furthermore, MUs within the tangent cylinder are shown to be structurally similar to helical plumes in rotating hydrodynamic experiments. We relate inner magnetic structures with their signature in terms of flux patches at the core-mantle boundary. We discuss the possibiliy to adapt our magnetic structure typology to conditions of the Earth's core.

Keywords: dynamo, visualization, numerical

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ASI001 **Oral Presentation** **3005**

Impact of data assimilation on initial conditions for geodynamo models

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Recent work on assimilating surface geomagnetic observations into geodynamo models has shown that the accuracy of secular variation prediction is enhanced by the assimilation, particularly if the assimilation has been carried out for timespans exceeding 100 years. This implies that the initial state for the model simulation, has in some sense been drawn closer to the true state of the Earth's core. The present work focuses on determining what changes in the initial state contribute to the improved prediction. We analyze several assimilation experiments which vary in length from 20 years to 400 years, and compare the changes to the magnetic and velocity fields in the outer core. This analysis enables us to understand how sensitive the accuracy of predicted secular variation is to improvements in state variables within the core, and how we should improve the assimilation methodology so as to further increase the accuracy magnetic field forecasts.

Keywords: assimilation, prediction, geomagnetism

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ASI001 **Oral Presentation** **3006**

Observation of Earth's core dynamics and constraints on the inner core axial rotation

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Some elements of the dynamics in the Earth's core, predicted either by theoretical or numerical models, are observed in the secular variation of the geomagnetic field. I will start by a review of some of these, among which we note the observation of decadal rigid cylindrical motions, likely representing torsional oscillations, and the presence of anticyclonic polar vortices, likely related to a thermal wind inside the tangent cylinder. Another observation, the eastward rotation of the inner core determined by body-wave seismology, may be consistent with either of these observations, representing either a steady rotation driven by thermal wind or a decadal oscillation driven by torsional oscillations. In this work, I show that the rate of a steadily rotating inner core is limited by the torque on the mantle from surface forces at the core-mantle boundary, while the rate of rotation of an oscillating inner core is constrained by the changes in mantle rotation induced by gravitational coupling, which must not exceed the observed changes in length of day. Using parameters estimated from various observations, I show that the maximum amplitude of an inner core oscillation at a period of 60 yr is ~0.03 deg/yr, while the maximum amplitude of a steadily rotating inner core is ~0.3 deg/yr. This implies that the largest inner core rotation rate compatible with the ensemble of seismic studies, 0.2 deg/yr, can only be explained by a steady rotation. Such a steady rate constrains the conductance of the lower mantle to be in the range of 1.6 - 2.5 x 10^9 S and the bulk inner core viscosity to be in the range of 2.5 - 4 x 10^{17} Pa s. Finally, I point out that the angular momentum balance associated with a steadily rotating inner core is compatible with the observed westward motions of magnetic field features at the core-mantle boundary, and that the latter are most likely due to advection by an underlying westward flow.

Keywords: geodynamo, inner core rotation, secular variation

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ASI001 **Oral Presentation** **3007**

Hydromagnetic instabilities in the Earth's core influenced by various types of anisotropic diffusive coefficients

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Hydromagnetic instabilities are studied in Cartesian geometry in the stratified horizontal fluid planar layer uniformly rotating about vertical axis. The layer is permeated by homogeneous horizontal magnetic field. We consider three basic cases of anisotropic diffusive coefficients (thermal diffusivity and viscosity) -- anisotropies of "o", "a" and "b" type. In the first two cases (o, a) the diffusive coefficients are horizontally isotropic but their horizontal values are distinct from the vertical value. In the "o" type, i.e. in the anisotropy of ocean type the diffusivities are greater in the horizontal direction than in vertical one, while in the anisotropy of atmospheric (a) type the vertical diffusivities are the greater. The "b" anisotropy is the anisotropy of Braginsky and Meytlis (1990) in which the eddy diffusivities are greater in the direction of magnetic field (in one horizontal direction) and in the direction of vertical rotation axis than in the 2nd horizontal direction. There are many various reasons to prefer in some states of some regions of the Earth's core the anisotropic case "o" or "a" or "b". Therefore, we compare all types of diffusive coefficients anisotropies in their role to facilitate or inhibit the onset of rotating magnetoconvection and how they influence the properties of arising instabilities. The case of isotropic diffusive coefficients is also studied and compared with all anisotropic cases. We try to indicate why geodynamo simulations with not too realistic parameters (e.g. Ekman number) are so succesfull using artificially defined hyperviscosity.

Keywords: hydromagneticinstabilities, earthcore, anisotropicdiffusivities

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ASI001 **Oral Presentation** **3008**

Turbulent structure in the Earth's core inferred from paleomagnetic power spectrum of the dipole moment

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Although the idea of estimating a turbulent state in the Earths fluid core by using magnetic field time spectra has been already given in earlier works (e.g. Currier, JGR, 1968), it is still a matter of speculation because the physical relation between the time series of the geomagnetic signals and the turbulent spectra is unclear. Recently, accumulation of paleomagnetic and geomagnetic data made it possible to estimate reliable power spectra of the dipole moment over a wide frequency range. According to the result by Constable and Johnson (PEPI, 2005), there are three characteristic spectral slopes, namely, from low to high frequency ranges, f^{0}, f^{-5/3} and f^{-11/3}, where f is frequency. Consolini et al. (PRE, 2002) conjecture that the high-frequency f^{-11/3} spectrum indicates turbulence in the presence of a strong magnetic field. In general, the time derivative of the magnetic dipole moment can be expressed as a surface integral of the electric current at the core-mantle boundary (CMB), provided that the mantle is a spherical insulator. Therefore, we can interpret the paleomagnetic dipole spectrum as the power spectrum of the electric current integral, |S(f)|^{2}, which has the spectral slopes of f^{2}, f^{1/3} and f^{-5/3}, according to the data by Constable and Johnson. In order to connect this information with turbulent wavenumber spectra in the core, we performed three-dimensional numerical simulations of geodynamo. We confirmed the |S(f)|^{2} spectrum in our numerical model has f^{1/3} and f^{-5/3} slopes. The low-frequency f^{2} spectrum was not clear because simulation length is still short. The |S(f)|^{2} spectrum can be interpreted as the azimuthal wavenumber spectrum of the electric current on the CMB. This is the result of Taylors hypothesis. In fact, we confirmed that the electric current shows an almost sectorial pattern on the CMB and the pattern moves westward with an almost uniform angular velocity. We further confirmed that the velocity power spectrum beneath the CMB is essentially the same; that is, it has characteristic slopes of m^{1/3} and m^{-5/3}, where m is azimuthal wavenumber. Similarity of the electric current and the velocity spectra can be explained by the dynamics in and around the Ekman-Hartmann layer. Our conclusion is that the corner frequency of the dipole power spectrum dividing the f^{-5/3} and f^{-11/3} slopes, approximately 2 kyr^{-1} (500 yr in period) in the case of the Earth, may indicate the peak azimuthal wavenumber of the velocity beneath the CMB. Assuming the same phase velocity of 0.2-0.3 degree yr^{-1} as that of the geomagnetic westward drift, we could infer that the velocity spectrum near the CMB has a broad peak around m=5 or less and is proportional to m^{-5/3} in the higher frequency range, which would extend to m=500, provided that the f^{-11/3} spectrum is still detectable at 0.2 yr^{-1} (5 yr in period).

Keywords: geodynamo, turbulence, paleomagnetic data

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ASI001 **Oral Presentation** **3009**

Kinematic dynamos revisited

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Presenting paper IAGA

Martin Dudley

The self-exciting dynamo mechanism is central to understanding the behaviour of the Earth's and other astroplanetary magnetic fields. The first numerically convincing laminar kinematic dynamos in sphericalconductors were reported by various authors between 1971 and 1975. All these dynamos were based on multi-cellular flows of some complexity. However, early in this period four models based on simple single or double cell axisymmetric flows were studied without yielding self-exciting dynamos (Fraser 1972). We have investigated these and other similar very simple flows, about twenty flows altogether. We find that each flow can generate a self-exciting dynamo. The resulting magnetic fields have various parities. Some fields are steady; the others are rapid rotators that are steady in some rotating reference frame. These positive results add weight to the occasionally made conjecture that all but special isolated flows (e.g. purely toroidal) probably support dynamo action in some region of parameter space.

Keywords: self exciting, dynamos

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ASI001 **Oral Presentation** **3010**

Nonlinear Stability of Spherical Dynamos

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The nonlinear stability of dynamically consistent spherical dynamos is investigated in the Boussinesq approximation using energy-like integral estimates. The self-exciting dynamically consistent dynamo problem is governed by the momentum, magnetic induction and heat equations. The integral estimates for the magnetic field and the velocity are the magnetic energy and the kinetic energy respectively, but the temperature estimate differs from the internal energy. From the energy-like estimates a variational problem is derived, whose solution establishes sufficient conditions for stability and necessary conditions for instability. In spherical geometries bounds are obtained which give weak conditions for stability. The Euler-Lagrange equations of the variational problem are derived in the case of an electrically insulating exterior for no-slip and stress-free boundary conditions. In this case the Euler-Lagrange equations are linear without approximation for no-slip or stress-free boundary conditions. The numerical solution of these Euler-Lagrange equations in spherical geometries is discussed and applied to several examples. The technique also applies to non-dynamo solutions of the magnetohydrodynamic equations and sub-problems such as magnetoconvection.

Keywords: nonlinear, dynamos, stability

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ASI001 **Oral Presentation** **3011**

Torsional oscillations in numerical dynamo simulations

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The integrated force balance on cylinders aligned with the planetary rotation axis is thought to be of special importance for the dynamics in the Earth's core. Only Lorentz forces, viscous effects, and inertia contribute to the balance on these so called geostrophic cylinders. Since the latter two contributions arelikely negligible it is expected that the Lorentz forces largely cancel in theso called Taylor state. Deviations from the Taylor state lead to magnetic restoring forces which in turn drive fast torsional oscillations of the geostrophic cylinders with periods of roughly 50 years. Magnetic coupling of the cylinders allows these oscillation to travel inward and outward as Alfvn waves.The importance of this special force balance, however, is less clear in numerical dynamo models where inertial as well as viscous effects are generally orders of magnitude larger than would be appropriate for Earth. We set out to explore torsional oscillation in various dynamo simulations, spanning Ekman numbers from E=3x10-4 to E=3x10-6. Explicit force balances on geostrophic cylinders are analysed and the applicability oftorsional oscillationtheory is checked in all cases.Strong viscous damping clearly prevents torsional oscillations at the larger Ekman numbers but is negligible in the small E cases. Reynolds stresses, a nonlinear inertial effect, remain to play a role in all models explored. They are,however, significantly smaller than Lorentz forces in mid shell at E=3x10-6. Here, torsional oscillations are excited locally at some cylindrical radius and then travel inward and outward with roughly the expected Alfvn speed. These waves also obey the predicted periods. However, classical torsional oscillation theory, that attributes torsional oscillationdynamics to variations in the azimuthal magnetic field only, fails to described the observed dynamics. We find that variations in other magnetic components can not be neglected. Finally, the cancellation of Lorentz forces on geostrophic cylinders is shown to be significant in the low Ekman number cases that seem to approach a Taylor state.

Keywords: dynamo

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ASI001 **Oral Presentation** **3012**

Zonal westward movement of short-term variations of the observed geomagnetic field. consequences for core surface fluid flow morphology

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Variations of the geomagnetic field at interdecadal and centennial time-scales, of internal origin, are isolated and their characteristics are discussed. Of particular interest is a 22-year variation, having amplitudes of 20-100 nT and showing systematic phase differences between observatories, which is significant in terms of secular variation at regional and local scale and in terms of ingredients of geomagnetic jerks. The time-space evolution of the radial component of the ~22-year variation, as appears from time-longitude diagrams in the time interval 1880-1990, indicates a westward zonal movement of its maxima and minima, which can be interpreted in terms of zonal motion of the nonaxisymmetric magnetic field at low latitudes at the core surface, either as vortices on top of a westward equatorial jet of core fluid or as propagation of hydromagnetic waves with components triggered by a direct action of solar activity on the geodynamo.

Keywords: geodynamo, 22 year variation, observatory data

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ASI001 **Oral Presentation** **3013**

Axial invariance of rapidly varying diffusionless motions in the Earth's core interior

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I argue that on 1yr/10yrs periods, the dimensionless number lambda appropriate to compare the rotation and magnetic forces is independent of the magnetic diffusivity in contrast with the oft-used Elsasser number. I illustrate this statement with a numerical study of the transient motions set up by an impulsive rotation of the inner core in a rapidly rotating spherical shell permeated by a magnetic field, such as the Earths fluid core. Axisymmetric torsional Alfvn waves are shown to arise spontaneously when lambda is made small enough. They propagate from the cylindrical surface tangent to the inner core both inwards and outwards. Noting that the value of lambda appropriate to the Earths fluid core is O(10-4), I argue that the property of axial invariance generalizes to other fast but non-axisymmetric motions. That is corroborated by a discussion of earlier numerical studies of dynamos and magnetic instabilities. Finally, I outline the application of this work to the investigation of the flows responsible for the secular variation of the Earth's magnetic field.

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ASI001 **Oral Presentation** **3014**

Investigating the stability of numerical dynamo solutions

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We investigate the stability of numerical dynamo solutions with respect to slight perturbations. This is done thanks to the fully deterministic nature of the so-called PARODY code jointly developed by Emmanuel Dormy and one of us (J.A.) for 3D numerical dynamo simulations (solving for magnetic induction and Boussinesq rotating convection), which makes it possible to restart the simulation from any time step of a reference run. Using one such reference run displaying a reversal, we investigate the sensitivity of the solution to perturbations implemented at various stages of the simulation, well before the onset of the reversal (at times of stable polarity), slightly before the reversal, and just at the beginning of the reversal. Preliminary results show that slightly perturbing the magnetic field in the solution can easily alter the course of the simulation and of the reversal, even when the perturbation is implemented slightly before the reversal. Once the reversal is started however, magnetic perturbations do not seem to be able to stop the decline of the dipole field towards zero. Interestingly, we observe some cases where this decline does not lead to a full reversal, but only to a short reversed polarity event (akin to an excursion). More results will be presented and discussed.

Keywords: dynamo, reversals, stability

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ASI001 **Oral Presentation** **3015**

A dynamo operating in the partly stable core of Mercury

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The magnitude of Mercury s internal magnetic field atthe planet s surface is only 1% of the geomagnetic field strength. An origin by an Earth-like dynamo is doubtful because the implied balance of Lorentz and Coriolis force inside Mercury s core should result in 30 % of Earth s field strength. We suggest a special type of dynamo that works deep in Mercury s fluid core below a stagnant layer. According to thermal evolution models the heat flux in Mercury s core is less than what can be conducted along an adiabatic temperature gradient. The models also predict the existence of a solid inner core. The rejection of sulphur associated with its growth would drive compositional convection. The combination of two sources of buoyancy leads to a deep unstable layer, while in the upper part of the fluid core the stabilizing thermal gradient dominates. For plausible values of the heat flow at the core-mantle boundary, the size of the inner core and the sulphur concentration, we estimate that the unstable layer has 20-60% of the outer core s thickness. Numerical models show that a dynamo operating in such a system generates a strong internal magnetic field that is dominated by small spatial scales. The contribution of the dipole and the quadrupole are weak in the dynamo region, but in contrast to the small-scale components they vary less rapidly with time. The dynamo field diffuses through the stagnant layer, where its rapidly changing parts are strongly damped by the skin effect. The axisymmetric dipole and quadrupole components pass with some attenuation and dominate the field structure outside the core. The field strength at the surface is 20-200 % of the observed strength for different models. Future observations by space missions will allow to test the model predictions, such as the strong dominance of axisymmetric low-order field components and the lack of detectable secular variation on a decadal time scale.

Keywords: dynamo model, planetary magnetism

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ASI001 **Oral Presentation** **3016**

Numerical dynamo modeling on massively parallel computers: Do local low order methods have the potential to replace spectral methods in the near future?

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Numerical simulations of planetary dynamos belong to the most challenging problems of computational geophysics. The flow regime in the liquid cores of terrestrial planets is so extreme that numerical models lack the temporal and spatial resolution to even come close to realistic conditions. Future progress in this field depends crucially on efficient numerical algorithms which are able to take advantage of todays massively parallel computers. From the mid-eighties on spectral methods have been the most popular algorithms for the simulation of planetary dynamos. The current trend to massively parallel architectures with continually increasing processor numbers however makes the future dominance of these methods questionable. This is due to the fact that the communication intensive transform between physical and spectral space, an unavoidable part of spectral schemes, tends to become inefficient for large processor counts. Alternative approaches which in theory have the potential to use the computing power of a huge number of processors have been developed by several groups during the last few years. The majority of these approaches use local low order discretization schemes on the basis of finite differences, elements or volumes. Up to now, spectral methods are still the algorithm of choice in most dynamo models and it is unclear if the local low order approaches will ever replace them. The primary reason is that ingenious coding facilitates good scaling even on hundreds of processors and that the inherent efficiency and accuracy of spectral methods is hard to surpass. In this talk, I compare both approaches and discuss their capabilities and limitations. Two model implementations in Cartesian geometry serve as a simple testbed for the efficiency and scalability of the methods. A fully spectral code based on Fourier/Chebyshev expansions of all unknowns is compared with a second order finite volume model. Tests are performed on three computing platforms which offer a successively increasing degree of parallelism: a Linux cluster with O(100) nodes which is typical for a machine at institute level, a cluster of IBM p690 shared memory machines with 512 CPUs in total and a newest generation Blue Gene/L supercomputer with more that eight thousand processors. Apart from the scaling properties, also the accuracy and efficiency of the methods are compared for both simple benchmark cases and for more demanding calculations. These include simulations of strongly turbulent rotating convection and of magnetostrophic states which are especially hard to simulate since viscous dissipation is virtually absent in this regime. It is hoped that a detailed comparison like this helps modelers to assess the capabilities as well as the limitations of dynamo models based on local discretization methods.

Keywords: geodynamo, algorithms

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ASI001 **Oral Presentation** **3017**

Integration of 7000 years of surface geomagnetic observations to numerical geodynamo modeling

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Constraining numerical geodynamo models with surface geomagnetic observations can be very important for improving numerical models for better estimation of the true state in the Earths core, and for understanding and forecasting geomagnetic secular variations. In the past several years we have developed the first geomagnetic data assimilation framework, MoSST_DAS, which includes the MoSST core dynamics model, an optimal interpolation (OI) data assimilation component and several geomagnetic field models. In this system, the Gauss coefficients at the surface of the Earth from the field models are used to modify the poloidal field in numerical dynamo solutions. Our previous studies with 400-year historical data (gufm1 and CM4) showed that the system can predict geomagnetic field over 20-year period very accurately, with an above 98% correlation between the field model results and the forecasts at the core-mantle boundary. In addition, the unobserved physical quantities, (e.g. the toroidal magnetic field and the velocity field) also vary significantly from original numerical dynamo solutions. However, it is necessary to examine further whether such variation is robust and positive, i.e. helping reduce the errors between the model output and the true state in the core. For this purpose, we implement in the MoSST_DAS the field models CALS7K, gufm1 and cm4 which combined cover the geomagnetic field over the past 7000 years. Therefore we can examine the changes in the toroidal magnetic field and in the velocity field for various initial time, and for various initial states.

Keywords: geomagnetism, geodynamo, data assimilation

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ASI001 **Oral Presentation** **3018**

Approaching smaller scales of core surface flows

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Geomagnetic models for recent epochs have benefited from global, even, high-quality satellite data. In these models (e.g. Olsen et al., 2006) small scales of the geomagnetic field of the order of 1000 km have been seen to change over only a couple of years. Such time-scales seem too short to be due to diffusive effects, on account of the high electrical conductivity of the core liquid iron. We support the previous suggestion (e.g. Hulot et al., 2002) that small scales of secular variation are due to advection of the main field by relatively small scales of the core flow. Up to now, they have been precluded from CMB flow models computed from geomagnetic data inversion, by imposing strong regularizations that minimize the flow complexity. The main reason is mostly of practical nature and not based on physical grounds. We further claim that the flows responsible for the observed SV are axial vortices, characteristic of the quasi-geostrophic balance which is expected to prevail inside the core. In this study, we show that small scales of CHAOS and POMME3 SV models require small flow scales to be explained. However, a too high RMS velocity would contribute to a large-scale SV signal stronger than the one observed. We do, accordingly, also establish an upper limit for RMS velocity of core flows responsible for the observed SV.

Keywords: core flow, inversion, secular variation

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ASI001 **Oral Presentation** **3019**

Paleomagnetic reconstruction of the global geomagnetic field evolution during the Matuyama/Brunhes transition

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K. Fabian

A Bayesian inversion method is presented to reconstruct the spherical harmonic expansion of the transitional geomagnetic field during the Matuyama/Brunhes reversal from paleomagnetic data. This is achieved by minimizing the total variational power at the core-mantle boundary during the transition under paleomagnetic constraints. The suitability of the proposed inversion technique is successfully tested by inverting four simulated paleomagnetic time series calculated from a geodynamo model. Four geographically distributed high quality paleomagnetic records of the Matuyama/Brunhes reversal are combined into a single geometric reversal scenario without assuming an a priori common age model. The obtained spatio-temporal reversal scenario successfully predicts most independent Matuyama/Brunhes transitional records. Therefore, the obtained global reconstruction based on paleomagnetic data invites to compare the inferred transitional field structure with results from numerical geodynamo models regarding the morphology of the transitional field. It is found that radial magnetic flux patches form at the equator and move polewards during the transition. Our model indicates an increase of non-dipolar energy prior to the last reversal and a non-dipolar dominance during the transition. Thus, the character and information of surface geomagnetic field records is strongly site dependent. The reconstruction also offers new answers to the question of existence of preferred longitudinal bands during the transition and to the problem of reversal duration. Different types of directional variations of the surface geomagnetic field, continuous or abrupt, are found during the transition. Two preferred longitudinal bands along the Americas and East Asia are not predicted for uniformly distributed sampling locations on the globe. Similar to geodynamo models with CMB heatflux derived from present day lower mantle heterogeneities, a preference of transitional VGPs for the Pacific hemisphere is found. The paleomagnetic duration of reversals shows not only a latitudinal, but also a longitudinal variation. Even the paleomagnetically determined age of the reversal varies significantly between different sites on the globe.

Keywords: paleomagnetism, field reversal, bayesian inversion

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ASI001 **Poster presentation** **3020**

Maximum entropy regularisation of the core flow inverse problem.

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Andrew Jackson

We integrate a maximum entropy image reconstruction technique into the process of modelling the core flow at the core-mantle boundary (CMB). Core flow models are usually built from a secular variation model via the induction equation in the frozen flux approximation, providing (i) an extra constraint about the flow morphology, to reduce the parameter space, and (ii) a regularisation, to reduce the unconstrained effect of the small scales. Eymin & Hulot [2005] have shown that the interaction between small scales of both the flow and the magnetic field can generate secular variation at large scales. A good parameterisation of this process (e. g. by considering this interaction as an error of modelling, Pais & Jault [AGU 2006]) is crucial in order to extract a maximum of information from the data. In this respect one should avoid adding unnecessary {it a priori} information, as done by the usual quadratic regularisations. These lead to underestimate the power at large wave numbers (of importance for the core flow), and imply a loss of contrast in the reconstructed picture of the flow at the CMB. Recently introduced to invert for magnetic field models (Jackson [2003]) the maximum entropy regularisation is known to provide sharper pictures, with a minimum of {it a priori} about their structure. We introduce this technique into the problem of retrieving the core flow, and apply it to the CHAOS model at the epoch 2002.5 (Olsen [2006]) using the tangentially geostrophic constraint. We present comparisons between flow models built from maximum entropy and quadratic regularisations, and discuss perspectives and implications for our method.

Keywords: geomagnetism, inverse problem, core flow

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ASI001 **Poster presentation** **3021**

Hydromagnetic dynamos in a non-uniformly stratified spherical shell

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Pavel Hejda, Maxim Reshetnyak

Magnetic fields in the universe are generated by a hydromagnetic dynamo which acts in a liquid part of their interiors. The geomagnetic field is generated similarly, i.e. by the Geodynamo action in the outer Earth's core. The outer Earth's core is probably non-uniformly stratified due to thermodynamic processes acting in this area. The most part of the outer Earth's core is unstably stratified, only very thin sublayer close to core-mantle boundary (CMB) is stratified stably. Similarly, the interiors of Giant planets are also non-uniformly stratified, especially the regions, in which the hydromagnetic dynamo action is situated. In these cases the hydromagnetic dynamo action is apparently influenced by non-uniform stratification. The numerical modelling of a hydromagnetic dynamo in a rotating non-uniformly stratified spherical shell using the control volume method is presented. Our results showed that the influence of a non-uniform stratification and viscosity to a hydromagnetic dynamo (the Geodynamo) action isnoticeable. They are compared to the case of an uniformly stratified spherical shell (this case will be presented for the parameters of the numerical dynamo benchmark). The generated magnetic fields are mostly dipole dominated. It is expected that the influence of a non-uniform stratification to a hydromagnetic dynamo (the Geodynamo) action will be stronger in the study of turbulence.

Keywords: hydromagnetic dynamo, non uniform stratification, control volume method

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ASI001 **Poster presentation** **3022**

Geomagnetic Jerk in the Late 1980s

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IGES NAS RA IAGA

Golovkov Vadim Petrovich

Usage of the series of secular variations from worldwide net of high-quality magnetic observatories operating recently, for longer time interval approaching up to the beginning of XXI century allowed more accurately estimate the epoch of jerk in around of 1990. In fact in the global scale this jerk appears in 1988-89. After it the next period of the geomagnetic field steady development begins, central epoch of which falls on 1991. It divides the jerk of late 1980s from the new period of activation of sharp changes in secular variations with central epoch, i.e. epoch of last global jerk of XX century, lying by prior results available recently, in the second half of 1990s. Thus, the analysis of contemporary data of magnetic observatories confirms a quasi-decade repeatability of jerks on the globe. Spherical harmonic model constructed by constant accelerations values before and after the jerk shows characteristic for variations of internal origins large regional feature of jerk of 1988-89. In result of this jerk appear intensive foci of secular variations in particular regions of the world. Investigation of the Earths liquid core surface motions velocities field allows to conclude that for the generation of jerks the flows of divergent character are responsible, which are proceeding from local centers as ascending streams and converge at other centers as descending, but the flows of rotor character arise between them owing to a partial twisting of divergent flows under influence of Carioles forces. The problem on observed quasi-decade recurrence of global jerks remains open up to date. Manifestation of the phenomena of stochastic resonance on composing the temporal characteristics of internal jerks under influence of geomagnetic variations of external origins during the periods of solar and geomagnetic activity seems be a probable hypothesis though the comparative analysis of the scale of jerks and sharp variations in the Earths axial rotation rate rather contradicts to the hypothesis about a possibility of influence of external with respect to the Earths surface phenomena on the processes taking place in the Earths liquid core.

Keywords: geomagnetic jerks

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ASI001 **Poster presentation** **3023**

The wavelet-analysis of time and space parameters of 60-years variation.

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The wavelet-analysis and statistical processing of its results is executed. for dataset of several observatories located in the Europe, Asia and Northern America It is shown, that sources of 60-years variations can be divided into two classes on spatial scales: regional (for example, the Europe) and local. It is shown, that the mechanism of 60-years variations has relaxating character. It is noted, that parameters of a source vary in time. Amplitudes and character of change of these parameters are localized within the limits of separate region. There is no flatly fixed similarity and synchronism in the variation dynamics of the different components, obtained in one observatory. It was shown, that there is most probably that the sources of 60-years variations have the property of anisotropy. It is assumed, that the mechanism possessing noted properties can be caused by reorganization of movements on the surface of a liquid core of the Earth.

Keywords: wavelet analysis, mechanism of 60yr variations

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ASI001 **Poster presentation** **3024**

Changes in magnetic pole and dipole orientation during the last 7 millennia

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Mioara Mandea

The mechanism in the Earth's core causing the geomagnetic field and its secular variation is not completely understood. The movements of magnetic and geomagnetic poles could offer valuable insight to gain a better understanding of the underlying processes. Spherical harmonic geomagnetic field models offer the possibility to study variations of the positions of the magnetic (dip) poles and the orientation of the dipole axis. We have studied the pole behaviour by means of different models, covering various time spans: from sub-decadal, based on recent, highly detailed satellite measurements, to century scale, based on observatory and historical data, and finally to a few millennia based on archeo- and paleomagnetic data. Here we present and discuss the movement of the different pole positions from 5000 BC until today. Our results show significant differences in direction of movement and velocity of the north and south magnetic pole respectively, with varying periods of stronger acceleration for one pole or the other.

Keywords: geomagnetism, poles, secular variation

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ASI001 **Poster presentation** **3025**

Core flow modelling: constraints from dynamo theory

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In recent history our understanding of the magnetic field and the generating motions of the molten iron in the Earths core have increased dramatically. The two major approaches to investigate fluid flow have been core surface flow modelling from magnetic data inversion and modelling of the dynamo itself. Core flow modelling involves downward continuation of the magnetic field to the core mantle boundary (CMB), then adopting the frozen flux approximation plus added assumptions e.g. tangential geostrophy to reduce non-uniqueness, to obtain fluid flow at the surface of the core. The main check on the validity of these flows has been observed changes in length of day. This study aims to test the fluid flow inversion more rigorously by using synthetic data of main field, SV and fluid flow from a self-consistent convection driven dipole dominated dynamo. The dynamo magnetic data are inverted and comparisons made with the true dynamo flow. Forward models of full advection and diffusion, from the dynamo data have been calculated to compare contributions to the secular variation. The amount of flow, which cannot be modelled by the inversion, has been calculated, including invisible flow (flow in the null space caused by the geostrophic assumption). The amount of flow produced by the inversion in the null space is also calculated. We have checked the validity of a new assumption called helical flow by studying the true properties of the dynamo flow. The helical flow assumption has also been used to produce inverted flows using the technique of Amit and Olsen (2004) and here we also present a new method computing the helical flow assumption in the spectral domain.

Keywords: core, flow, dynamo

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ASI001 **Poster presentation** **3026**

On core flow modeling from observatory-based magnetic models; an allowance for time-varying practical null-space in the flow inversion

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Historical record of geomagnetic field measurements provides us with a possibility of imaging the temporal evolution of horizontal core flow just below the mantles base. Time-series models estimated in previous studies have made successes in giving important insights with regard to decadal dynamics of the Earths fluid core, such as the torsional oscillations. Yet, the flow imaging is still subject to uncertainty due to the risk of making up false images that only generate secular variation (SV) signal below the level of its error, or artifactual flows belonging to a practical null-space in the flow inversion. This null-space varies in time depending on main field model, and so may vary artifactual flow distribution possibly present as a part of resulting model even on large spatial scales. Indeed, typical flow models exhibit vigorous fluctuations, particularly in azimuthal flows at lower degrees when estimated with a priori assumption of tangential geostrophy. Of particular notice is time variation of power spectra from non-axisymmetric flows; their powers at lower degrees fluctuate considerably in correlation with one another, and have significant peaks around 1920 in accordance with the increase in the SV energy (these features are in contrast to the much longer timescales of core flows driven by the thermal core-mantle coupling). In this study we attempt to alleviate the ambiguity of time-series core flow model caused by the effect of time-varying practical null-space. Artifactual flow may be rendered to have exaggerated time variability by estimating flow models with time-invariant hyper parameter for regularizing the inversion despite the time-dependence of practical null-space. We therefore aim to seek appropriate degree of regularization (in terms of minimization of either kinetic energy or roughness of flow model) for each epoch so that the non-axisymmetric flow spectrum can be more stable in time. This treatment may be effective for resolving azimuthal flow evolution at lower latitudes, as they have been claimed to be well retrieved if the true core flow spectrum were known. We thus make a new estimate of time-series flow model by inverting geomagnetic model gufm1 from 1840 onwards with the tangential geostrophy assumption. In order to confirm the model reliability a test is implemented by examining whether the model agrees with the decadal LOD observations assuming core-mantle angular momentum conservation. The requirement of stable flow spectrum does not significantly impair the agreement with the LOD variations, as in the further constrained case with the steady flow in azimuthally drifting frame, which have been shown to account well for the LOD variations even in earlier epochs.

Keywords: core flow, inversion, null space

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ASI001 **Poster presentation** **3027**

Magnetic and thermally driven instabilities influenced by the position of the critical level

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The considered system is a horizontal stratified plane layer filled by the electrically conducting inviscid Boussinesq fluid rotating with a constant angular velocity under a vertical gravitational field and a nonuniform magnetic field. The imposed magnetic field is of linear profile and it has a zero point inside the layer by what the condition of the existence of a critical level is satisfied. An influence of the positioning of the critical level on the onset of instabilities was investigated. Linear stability of the system was performed. Instabilities were obtained in the form of stationary convection (oblique rolls) in dependence on dimensionless parameters (Rayleigh, Elsasser numbers) and on boundary conditions (perfectly conducting, insulating or mixed boundaries). Several kinds of instabilities were found of which the so called quasi-sinuous and quasi-varicose modes were preferred. Mostly the quasi-sinuous modes were the most advantageous. Eigenfunctions of instabilities in z-direction were strongly influenced by the asymmetry of the basic magnetic field. The chosen boundary conditions had a strong influence on the oset of an instability. Generally, the perfectly conducting boundaries facilitate the onset of magnetic or thermally driven convection.

Keywords: critical level, magnetic instability, thermal instability

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ASI001 **Poster presentation** **3028**

The global geomagnetic field during the Laschamp excursion

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Among the best examined features of past geomagnetic field variation is the Laschamp geomagnetic excursion, which took place approximately 40 kyrs ago. It has been suggested previously that the field geometry during this transitional field state is rather simple. Strikingly similar patterns of transitional field behavior are observed in many geographically distributed sampling locations.Using a Bayesian inversion method the global geomagnetic field evolution during the Laschamp excursion is reconstructed. The total variational power at the core-mantle boundary is minimized under paleomagnetic constraints. Several high quality paleomagnetic reversal records are combined into a single excursion scenario without assuming an a priori common age model. By iteratively applying the inversion procedure to geographically distributed records, a low degree global field evolution model is constructed which then is tested against all other available paleomagnetic records of the Laschamp excursion. The predictions from the model are are compared to paleomagnetically observed characteristics like transitional VGP movements and paleointensity variation.

Keywords: laschamp excursion, bayesian inversion

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ASI001 **Poster presentation** **3029**

Spatial heterogenity in geomagnetic preferred scales in historical secular variation and numerical dynamo simulations

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The technique of bootstrapped discrete scale invariance quantifies characteristic timescales of a process, based upon log-periodic fits of modulated power law scaling of size-ranked event durations. When applied to a large number of time series derived from a gridded time-dependent map, a spatial profile is obtained of local variability in threshold-dependent dynamics. Global and local characteristic scales, in absolute fluctuation magnitudes and associated durations, are visualised for dipole-detrended historical geomagnetic field map gufm1, and for a number of numerical geodynamo simulation samples. Spatial heterogeneity in preferred scales is found, with specific patterns in simulations dependent on modelling parameter choices and boundary conditions. This approach yields quantified scaling parameters that may help to constrain future geodynamo simulations, and may also be useful for analysing other types of spatio-temporal complex systems.

Keywords: characteristic scales, discrete scale invariance, secular variation

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ASI002 **3030 - 3047**

Symposium
Paleomagnetism and geodynamics neotectonics, continental reconstruction, reference frames

Convener : Prof. Erwin Appel, Dr. Silvana Geuna
Co-Convener : Mrs. Otofuji Yo-Ichiro

The symposium adresses paleomagnetic reconstructions on different scales and within different geological periods. New data from magnetic remanences, magnetic anomalies and hotspots are welcome in order to improve the reference frames of major plates and smaller terranes. A major topic of the session concerns intracontinental deformation in fold belts and fault zones including neotectonic processes. It is of particular interest to interpret the paleomagnetic results in the framework of geological constraints, geophysical models of the lithosphere structure, seismological data and GPS movements. Presentation of new methodologies to deal with primary and secondary remanences in deformed rocks is also invited

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ASI002 **Oral Presentation** **3030**

Jurassic intermediate VGPS, Pangea Subduction Zones and Seismic Wave Propagation in the Lower Mantle

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van Zele Mara Andrea

The objective of this work is to observe if Jurassic intermediate VGP's from different sequences could be correlated with Pangea subduction zones. Paleomagnetic data that belong to a time span between circa 200 Ma and 135 Ma were compiled from reliable magnetostratigraphic studies. The VGP's were repositioned in the geographic locations that they had had during the Jurassic, using hot spot tracks and the corresponding paleomagnetic poles of each sequence. VGP's between +- 60 of latitude were considered intermediate. To avoid that the intermediate VGP distribution was biased for those sequences with more data, each VGP was weighted by Loves methodology. A colour- scale map of density of the weighted intermediate VGP's was obtained and compared with the Pangea subduction zones. There is a good correlation between the density of these VGP's and the Pangea subduction zones what suggests that there is a relationship between the Jurassic geomagnetic field and the plate tectonics of this geological period. The areas where the Jurassic intermediate VGP's are distributed are also in very good coincidence with those of faster seismic wave propagation in the lower mantle (just above of the core-mantle boundary), what suggests that the Jurassic geomagnetic polarity transitions could have been controlled by a structure of the core-mantle boundary similar to that of the Present time. It is hypothesized that the subducted lithospheric slabs refrigerated the deepest mantle causing a radial heat flow from the core that controlled the geometry of the Jurassic polarity transitions.

Keywords: pangea, subduction, polarity transitions

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ASI002 **Oral Presentation** **3031**

Geophysical survey of the Fagnano pluton. Tierra del Fuego. Argentina

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Finance Committee of the Union Member IAGA

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The Lago Fagnano, located in the central area of Tierra del Fuego Island, is the result of transtensive tectonics responsible for several pull-apart basins associated with the transform Magallanes-Fagnano Fault System (MFS). At the southeastern tip of the lake a small monzodioritic intrusion outcrops, the Jeujepen pluton. Previous aeromagnetic map pointed to the probable presence of another pluton in the central northern margin of the Lago Fagnano. There, an aeromagnetic anomaly of around 35 km2 shows an asymmetric distribution of contour lines with the highest values in the east (reaching values > 1200 nT). Last November a geophysical survey was carried on in the area of the aeromagnetic anomaly. Data acquisition in the field involved magnetic measurements at GPS-fixed stations with a proton magnetometer, sampling for susceptibility, paleomagnetic and AMS determinations at each lithologic type completed with petrologic and structural data survey. The outcrops correspond to dark schists and sedimentary rocks pertaining to the Lower Cretaceous Beauvior Fm. which are deformed by Upper Cretaceous Andean compressive tectonics. This unit hosts an alkaline pluton the Fagnano pluton- composed of basic to acid terms, dominated by gabbro-syenite association enclosing ultrabasic enclaves. The pluton is cut across by faults of the MFS. The aereomagnetic survey and magnetic measurements integrated with the geological information allowed to model an N-S cross section through the area. Preliminary processing of available data along with the location of Fagnano pluton along the strike of MFS allow to propose that its emplacement was governed by a transtensive regime associated with this transform fault activity.

Keywords: southernmost andes, pluton emplacement, magnetism survey

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ASI002 **Oral Presentation** **3032**

Paleomagnetism of Late Tertiary lava flows from Lundarhals, Storutjarnir, and Su durdalur, Iceland

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IAGA

Paleomagnetic sampling of Tertiary lava flows was carried out by our group (Tokyo Institute of Techonology, Kochi University, University of Tokyo, University of Iceland) in 1993 and 1994. In total, 489 lavas were sampled. For paleomagnetic purposes, five oriented cores were obtained at each site. In the laboratory, one specimen from each core was subjected to stepwise alternating demagnetization. For about 20 % of all samples, 10 steps with a maximum of 50 mT were employed. For the other samples, the demagnetization was done in 15 steps to a maximum field of 100 mT. For some selected samples, hysteresis and thermomagnetic anal yses were carried out to characterize the magnetic minerals. The Curie temperatures ranged between 200 and 600 degree C, suggesting that the carrier of remanent magnetization are titanomagnetites with various degrees of oxidation. Characteristic remanence directions were determined by principal component analysis. For some of the lava flows, K-Ar dating was carried out at ISEI, Okayama University. These experiments were carried out through the years 1994--2004, but most of the measurements were finished by 2001. The publication of the results were, however, much delayed for various reasons. Only the results for Jokuldalur section (38 lava flows) was published (Udagawa et al., Phys. Earth Planet. Inter., 115, 147--171, 1999). In this study, we found the evidence that the Gilsa event is, although short, a distinct short normal period separate from the more prominent Olduvai event. In this talk, I would like to summarize the paleomagnetic results from other areas of Iceland. In Lundarhals area, which is in the western Iceland north of Reykjavik, we collected samples from 182 lava flows belonging to nine continuous sections. The age of these lavas are considered to be 4--6 Ma, based on magnetic stratigraphy. The remanence in this area are dominated by reverse polarity. Only in one section (VM), the number of normal and reversed lavas are about equal. There are three other sections in which short normal period was found (VS, VT, VB). In all the other sections (VA, VC, VD, VF, VG), all the lavas showed reverse polarity. It may be that these sections represent relatively short period of time dominated by reverse polarity. Two sections were sampled in Storutjarnir. Some of these samples were dated by K-Ar method and gave the ages of 2--4 Ma. The LT section is composed of 93 lava flows, and showed R-N-R-N-R-N-R-N polarity changes from bottom to top. Among them the upper two reverse polarities were recorded by one flow each. The SI section (77 lavas) showed R-N-R-N from bottom to top. These two sections are about 3 km apart and taken from the gulleys cutting the same mesa-like plateau, but exact corrlation of flow to flow was very difficult even with the use of magnetic directions, lithology, and K-Ar dates. This may be showing that the volcanic a ctivity of one center is rather limited, even when seemingly continuous and nearly flat hills continue for several kilometers. Two sections were also sampled in Sudurdalur area. The age of the lavas are presumed to be 4--6 Ma based on magnetic stratigraphy. In MA section (47 lavas), a R-N-R-N-R (bottom to top) sequence was found. The MB section (52 lavas) is stratigraphically younger than the MA section, and exhibits R-N-R-N-R-N-R section. These two sequences should overlap about 1/2 to 2/3, but exact correlation is not possible yet.

Keywords: paleomagnetism, iceland, tertiary

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ASI002 **Oral Presentation** **3033**

Break-up of Pangea and early Mesozoic plate motions in the central Atlantic, Atlas and Tethys regions

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Eugenio Turco

A new Pangaea fit (type A) is proposed for the late Ladinian (230 Ma), together with a plate motion model of the break-up of Pangaea from middle Triassic to chron M25. This model is based upon: a) an interpretation of the mechanism of formation of the East Coast and Blake Spur Magnetic Anomalies along the eastern margin of North America, and the S1 magnetic anomalies along the conjugate margins of northwest Africa and the Moroccan Meseta; b) an analysis of major rifting events in the central Atlantic, Atlas and central Mediterranean; c) a crustal balancing of the stretched margins of North America, Moroccan Meseta and northwest Africa; and d) a new apparent polar wander path of Africa since middle Triassic. The model of Pangaea break-up between the late Ladinian (230 Ma) and the oldest identified oceanic magnetic anomaly (M25, 154.3 Ma) considers three stages. During the first stage, from the late Ladinian (230 Ma) to the middle Norian (210 Ma), Morocco was fixed with respect to North America, whereas rifting proceeded along the eastern margin of N. America, the northwest African margin, the High, Saharan and Tunisian Atlas, and in the central Mediterranean. During the second stage, from the middle Norian (210 Ma) to the late Pliensbachian (185 Ma), the Morrocan Meseta separated from North America and left-lateral transcurrent motion occurred along the Middle Atlas, which acted as a transform plate boundary between the Moroccan Meseta and eastern Morocco. Finally, during the third stage from the late Pliensbachian (185 Ma) to chron M25 (154.3 Ma) the main plate boundary jumped northward between Morocco and Iberia, whereas no motion occurred along the Atlas fault systems. A set of plate tectonic reconstructions and an animation are proposed to illustrate the changing configuration of the continents during the break-up of Pangea.

Keywords: plate tectonics, pangaea, apw paths

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ASI002 **Oral Presentation** **3034**

Internal deformation of the Shan-Thai block in Southeast Asia due to collision of India: Paleomagnetic evidence from Mesozoic sedimentary rocks in Yunnan and Northern Thailand

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Paleomagnetic samples of red sandstones were collected at 31 sites from the Cretaceous Jingxing and Nanxin Formation around Puer (23.0N, 101.0E) and at 16 sites from the Lower to Upper Jurassic Phu Kradung and the Upper Jurassic Phra Wihan Formations around the Nan city (19.2N, 101.0E) in the Shan-Thai block. After stepwise thermal demagnetization, a high-temperature component with unblocking temperature of about 680 C is isolated from 36 sites. Positive field tests show that the high-temperature component magnetizations from 25 sites for Puer and from 11 sites for Nan are primary origin. A tilt-corrected mean direction for the Cretaceous formation in Puer is D = 59.9, I = 45.2 with a95 = 5.1, while that for the Jurassic formation in Nan is D=32.3, I=33.3, a95=12.2. These data indicate that the Puer area experienced clockwise rotation of 46 with respect to the whole China block while the Nan area was subjected to clockwise rotation of 12.8. Rotation aspect of the Shan-Thai block is described as a large rotation of more than 45 within a narrow zone extending from Luxi through Puer to Mengla in its central region and a moderate rotation in both northern and southern regions. This aspect gives us a two step rotation model. A coherent whole block rotation by about 20 of the Shan-Thai block took place in earlier phase during indentation of India into Asia and an internal deformation with additional local rotation between 22 and 47 followed at the limited zone in the central region. The internal deformation of the Shan-Thai block absorbed the stress on the Asian continent induced by indentation of India as well as its coherent whole block motions of the clockwise rotation and southward displacement.

Keywords: asia, collision, deformation

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ASI002 **Oral Presentation** **3035**

Magnetostratigraphic and magnetofabric investigations on the Cenozoic sediments of the Assam - Arakan Basin, North-East India

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A.K. Mullick

We present a magnetostratigraphic and magnetic fabric (AMS) study on a 5500 m Cenozoic sedimentary section, which is exposed along the New Silchar-Halflong Road, of the Assam Arakhan basin. The studied section consists of seven formations namely- Tipam, Bokabil, Upper Bhuban, Middle Bhuban, Lower Bhuban, Jenam and Renji Formations. In this investigation, a combination of thermal and AF demagnetizations (150 thermal demagnetization followed by AF demagnetizations up to 100 mT) were adopted to isolate the charactetristic remanent magnetization directions from 450 samples collected from 270 sites. Our demagnetization protocol was found successful in isolating the ChRM directions from the samples yielding a magnetic polarity stratigraphy (MPS) containing 18 normal and 21 reversal polarities. The obtained MPS was matched with the standard geomagnetic polarity time scale (GPTS) and the ages for the studied formations were defined between 6 Ma to 30 Ma. The average sediment accumulation rate (SAR) was noticed as 24 cm/ka with an unconformity of 2.14 Ma between Renji and Lower Bhuban Formations. The rock magnetic investigations on these samples indicated that magnetite was the major magnetic mineral carrying the ChRM directions and goethite along with pyrrhotite were carrying the viscous secondary components. Low field AMS measurements on these samples yielded well defined three principal magnetic susceptibility axes (Kmax, Kint, Kmin) exhibiting the oblate magnetic fabrics. Magnetic foliations and lineations data suggested a NE-SW directed palaeo-current directions, indicating the sediment input was from the positive areas like Mishimi Hill, which is located at the northeastern margin of the Assam-Arakan Basin.

Keywords: magnetostratigraphy, magnetiofabric, assam arakanbasin

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ASI002 **Oral Presentation** **3036**

Major Clockwise rotation of Northeast Africa during the Late Triassic- Early Cretaceous time: A paleomagnetic study on the alkaline intrusions in the South Eastern Desert of Egypt

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Three alkaline intrusions in the Eastern Desert of Egypt were paleomagnetically studied: The Late Triassic Bir Um-Hebal intrusion (223Ma) and the two Early Cretaceous ring complexes of Mishbeh (142Ma) and Nigrub el-Fogani (139Ma). The collected samples were drilled after digging 25-50 cm to avoid surface weathering. The isothermal remanent acquisition/thermal demagnetization reflected the predominance of magnetite as the remanence carrier. The progressive thermal demagnetization of all samples revealed a soft present-day field overprint followed by a coherent characteristic remanence [ChRM]. The ChRM of 13 sites from the Late Triassic Bir Um-Hebal intrusion [23.75N/33.25E] had dual polarity with mean Dec./Inc.=346/-14, K=51 , ɑ 95=6 and a pole at 56N/239E. The Early Cretaceous Mishbeh Ring [22.75N/34.7E] had bipolar NW-SE shallow inclination with a mean of 15 sites at Dec./Inc.=329.5/-21, K=28, ɑ95=7.3 and a pole at 45N/259E, while Nigrub el-Fogani ring[22.85N/ 34.95E] had only reverse SSE shallow positive inclination with a mean of 12 sites at Dec./Inc.=153/17.5, K=32, ɑ95=7.7 and a north pole at 48N/258E. The obtained poles are comparable with coeval poles from Africa and those rotated from the main tectonic units. Comparing paleomagnetic poles of the present study it can be concluded that: - Northeast Africa was equatorial during Late Triassic- Early Cretaceous time so that Cairo [now at 30N] was 1-3 south of the equator. - During that time interval NE Africa had, apparently, rotated 14-17 clockwise. This rotation had, apparently, intiated the dispersion of Pangaea and seems to be the contribution of the African Plate during the rifting of the Central Atlantic.

Keywords: egypt africa, ring complex, paleomanetism

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ASI002 **Oral Presentation** **3037**

Hotspot Drift vs. True Polar Wander

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Paul Wessel

Fixed hotspot is one of the first idea for the Plate Tectonics about 40 years ago, and is still useful for the calculating absolute plate motions and the true polar wander path. Recently, however, simulated models of hotspot drifts by such as Steinberger et al.,2004 have become popular, more people accept the idea that hotspots can drift several centimeters a year. It is important to clarify the velocity distribution of global hotspots for understanding global mantle dynamics. One can regard easy to estimate the velocities by calculating discrepancy between observations and fixed hotspot model, but it is rather hard to do that. There are two reasons for it. First, positions and ages of hotspot seamounts on a plate may be explainable with fixed or very slow moving hotspot model if a proper model of the plate motion introduced. Second, southward drift of paleolatitude of Hawaii-Emperor chain (Tarduno et al.,2003) can be explain not only by hotspot drift but by true polar wander. Thus, we need to know as accurate true polar wander path as possible.In this paper, I would like to summarize results of data analysis related to the topic, and like to show two important conclusions; observed data is quite consistent with the idea of fixed hotspot or very slow moving hotspots, and southward drift of paleolatitude of Hawaii-Emperor chain can be explainable with newly revised model of true polar wander path. The true polar wander path can be regard as relative motion of spin axis and mantle, and the motion is in harmony with the model of Mantle Roll (Jurdy,1981).

Keywords: hotspot drift, plate motion, true polar wander

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ASI002 **Oral Presentation** **3038**

Palaeomagnetism of Miocene volcanics in Biga Peninsula, NW Turkey

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geophysics EGU, AGU IAGA

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Neotectonic period commenced in Early Miocene in Turkey when the southern Neotethys closed completely, leading the collision of Arabian Platform with the Anatolides. Continuing convergence resulted in westward escape of a central Anatolian micro-plate, accommodated by the dextral North Anatolian Transform Fault (NAF) in the north and the sinistral East Anatolian Transform Fault (EAF) in the southeast. While the eastern Anatolia started to rise, forming a high plateau due to the compression at the collision front, the Western Anatolia underwent stretching in the N-S direction. Lithospheric stretching of Western Anatolia culminated in formation of an E-W and NE-SW trending horst-graben systems and exhumation of metamorphic massifs as core complexes. This area is known as the second fastest extending region in the world, characterized by astenospheric upwelling, high heat flows and magmatism. The study area is located to the north of the E-W trending Edremit Graben in the Biga Peninsula, Western Anatolia. Kazdag Mountains at the northern side of the graben forms one of the highest mountain in the area. High grade metamorphic rocks, known as the Kazdag massif, are exposed at the summits of these mountains, while the flanks are occupied be the Late Oligocene and Miocene volcanic rocks. The Kazdag Massif is interpreted as an Oligo-Miocene core complex structure (Okay and Satir, 2000). The massif is eliptical in map view and is bordered by low angle detachment faults. The Miocene volcanics crop out at the hanging wall of these detachment faults. In this study, we present the results of rock magnetic and palaeomagnetic investigations of the Miocene volcanics from the south of Biga Peninsula. The studied rock types are mainly ignimbrites. To determine the horizantal and vertical rotations in the area, palaeomagnetic samples were collected from 40 sites. Samples from 32 sites yielded reliable remanent magnetization directions. We have applied conglomerate test at one site to test if the area was exposed to a remagnetisation. According to conglomerate test, the volcanic rocks in the area did not gain a remagnetization. To determine the magnetic properties of the samples, we applied detailed rock magnetic measurements such as hysteresis loops, Curie temperature curves and low temperature experiments. In addition to rock magnetic studies, XRD measurements were performed to determine the magnetic mineral content in the rocks studied. According to the rock magnetic studies, samples from 38 sites are in the Pseudo Single Domain range and magnetite is the main magnetic mineral. Thermal demagnetization had been applied to all of the samples to gain the magnetization directions. Statistic parameters are also reliable according to thermal demagnetization steps. Early-Mid Miocene samples declinations show 49o clockwise rotations from younger formations to older ones. This rotation is explained by the exhumation of Kazdag core complex along the detachment faults from north to south. The present trend of the Kazdag core complex and the results of this study is consistent. Moreover, Late Miocene volcanics in the area is effected by the rotations along N-S extending faults. References OKAY, A. I. & SATIR, M., 2000. Coeval plutonism and metamorphism in a latest Oligocene metamorphic core complex in northwest Turkey, Geol. Mag. 137 (5), pp. 495516.

Keywords: palaeomagnetism, rockmagnetism, nwturkey

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ASI002 **Oral Presentation** **3039**

Evidence of stable secondary pyrrhotite remanences in the high himalayan crystalline of Solo Khumbu (Nepal): mechanism and thermo-tectonic implications

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Erwin Appel

Aiming at testing the suitability of the high-grade metamorphic gneisses (upper amphibolite to granulite facies) of the High Himalayan Crystalline (HHC) for paleomagnetic investigations sampling has been conducted in the Solo Khumbu area on a south-north section at ca. 87E along the Dudh Kosi from a few km south of Lukla (close to the Main Central Thrust) to Namche Bazar in the North. Twenty sites with at least ten oriented cores per site were drilled. A dominant and stable characteristic remanence component residing in pyrrhotite (ChRMpyr) could be separated, based on its unblocking temperature range (major unblocking between 250-350C) and coercivity (median destructive field > 100mT). The presence of pyrrhotite is also demonstrated by thermal demagnetization of SIRM. Our data evaluation reveals a wide abundance of stable and well-grouping ChRMpyr directions not reported with such significance from any other area of the high metamorphic HHC. We believe that the pyrrhotite had been formed during cooling as it is not stable at peak metamorphic temperatures of the gneisses (550-700C). Grain sizes of the pyrrhotite are obviously in a sufficiently hard coercive range to enable stable remanence recording below the Curie temperature (ca. 325C) in a temperature range where ductile deformation had stopped. The ChRMpyr is most likely a thermoremanence acquired during last metamorphic cooling event (Miocene). Normal and reverse polarities are observed, partly co-existing within single specimens, supporting its thermoremanent origin. We assume that pyrrhotite occurs as hosted inclusions (nano- to micrometer scale) in the silicate minerals of the gneisses (e.g. plagioclase and garnet). Consequently, the structure and grain size of the host minerals will define the remanence behavior of pyrrhotite. We are expecting more concise results from domain structure analysis. The thermoremanent origin of the ChRMpyr allows the determination of remanence-acquisition ages (~ age of last peak metamorphic cooling event), and quantification of late-orogenic block rotations and long-wavelength folding/tilting in the zone of frontal collision between India and Eurasia.

Keywords: pyrrhotite, thermoremanence, tectonics

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ASI002 **Oral Presentation** **3040**

IITPW hypothesis and new data on paleomagnetism of Lower Cambrian of South-East of the Siberian Platform.

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One of the most intriguing scenarios to explain the crucial events of the Earth's history, which took place close to Precambrian-Cambrian boundary, wassuggested by Kirschvink and coauthors (1997) who proposed a possible episode of inertial interchange true polar wander (IITPW). This feature would correspond to a fast migration of 90 of the geographic reference frame relative to the spin axis, when the maximum and the intermediate inertial Earth's axes would interchange. If the Kirschvink's explanation is true, we should observe around the Lower-Middle Cambrian a rapid drift of about 90 in the apparent polar wander path from all continents.The Siberian Lower Cambrian paleomagnetic pole, obtained by Kirschvink (1984) from the Pestrotsvet Formation cropping out along the Lena river, is one of the cornerstones of IITPW hypothesis. This pole is notably different of the Middle Cambrian pole of the Siberian platform (Gallet et al, 2003) with an angular distance about 70. This difference may therefore be in agreement with an episode of major true pole drift between the Lower and the Middle Cambrian, however, there are some problems with the pole obtained by Kirschvink. One of the problems arises from the fact that until recently this pole could not be confirmed by other studies made by Russian and West-European paleomagnetologists (Pisarevsky et al., 1997; Torsvik et al., 1998). In contrast, the other existing Lower Cambrian paleomagnetic data are very different and much closer to Middle Cambrian pole (e.g. Pisarevsky et al., 1997).Our study was aimed at investigation of numerous Lower Cambrian key sections of South-East of the Siberian platform with the purpose to confirm or contest the reality of Kirschvinks pole existence. During some years we have studied more than 1200 samples from tens distant key sections (Maya, Aldan , Gonam, Djanda, Aim rivers valleys). In spite of the fact that in all these sections the modern strong and very persistent component of magnetization predominates we have managed to isolate in most part of them the ancient high temperature component with northern declinations and moderate inclinations. These paleomagnetic directions are consistent with expected ones (Khramov directions), calculated from poles, previously obtained by Russian researchers (see Pisarevsky et al., 1997) and are in keen disagreement with Kirschvink direction.At the same time very often we observe the traces of presence of other high temperature stable component, expressed, in particular, by remagnetization circles and by some peculiarities of paleomagnetic signal behavior during demagnetization. With exception of 3-4 samples we havent succeeded to isolate this magnetization. Nevertheless, there is some regular pattern in remagnetization circles positions the normals to their planes are grouped in south-eastern and north-western parts of stereogram like it was observed by Kirschvink (1984). This feature seems to confirm the reality of Kirschvink direction.The simplest explanation is to accept that the Kirschvink direction is the primary one and Khramov direction is a result of a metachronous remagnetization. However such the explanation faces difficulties among which the most important ones are: 1) statistically significant difference between Middle Cambrian and Khramov poles positions; 2) Khramov directions are widespread in the territory of the Siberian platform in the regions with very different geological history, while there are no signs of any event which could be the cause for all-platform remagnetization; 3) studied riphean rocks of South-East of the Siberian platform do not carry Khramov magnetization.These data impel us to look for another explanation of observed phenomenon. We speculate that one should search such the explanation in some anomalous behavior of geomagnetic field at the Precambrian-Cambrian boundary.

Keywords: lower cambrian, iitpw hypothesis, paleomagnetism

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ASI002 **Poster presentation** **3041**

Analysis of a Permo-Triassic polarity transition in different absolute reconstructions of Pangaea, considering a model with features of the present earth magnetic field

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van Zele Mara Andrea

The main objective of this work is to show that the distribution of transitional palaeomagnetic data recorded at 250 Ma are in agreement with simulated data that depend on the sampling site, using a model that considers features of the Present Earth magnetic field. The analysis was performed comparing simulated reversals with the Permo-Triassic polarity transition recorded in the Siberian Trap Basalts. The palaeomagnetic data were corrected according to the palaeo-latitude and palaeo-longitude of Siberia (absolute reconstruction) at 250 Ma using hotspot tracks. To obtain the motion of Siberia relative to hotspots from Present time till 250 Ma, three different models of Pangaea were considered (Pangea A, Pangea A2, Pangea B). In spite of the uncertainties related with hotspot frameworks and Pangea configuration, the modelled and recorded data show a remarkable fit when absolute reconstructions of Pangea A and A2 configurations are performed. The agreement between both simulated and recorded data suggests that similar features of the Present Earth magnetic field could have been involved in the reversals since the Permo-Triassic.

Keywords: permo triassic, pangea, polarity transition

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ASI002 **Poster presentation** **3042**

Magnetostratigraphy Section of the Late Pliocene Pleistocene of Armenia

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This abstract presents the results of palaeomagnetic studies of Pliocene Pleistocene effusive rocks of Mt. Aragats and some adjacent regions, continental Pliocene sedimentary rocks of the Shirak depression and Holocene lacustrine river formations of Lake Sevan basin. The laboratory studies complex (definition of ferromagnetic carries primary magnetization (In), temperature and time cleanings, and cleaning with the variable magnetic field) proved the termoresidual nature In of Pliocene Pleistocene effusive rocks of Mt. Aragats massif and the orientational nature of continentals Pleistocene sedimentary rocks of Shirak depression and Holocene lacustrine-river for motions of Lake Sevan basin. To determine composition and structure of the ferromagnetic fraction flowing methods were used: the method of termodifferential analysis, the method of saturation parameters. After summarizing the results of laboratory investigations made it possible to prove the palaeomagnetic usatibily of studied rocks what serve as the basis for compiling the palaeomagnetic scale of Armenia. The coordinates of virtual poles for Pleistocene era were calculated from the value D and J of the primary magnetization. Palaeomagnetic investigations of effusive rocks Aragats massif and some adjacent regions the late Pliocene Pleistocene, continental Pliocene deposits of the Shirak depression and Holocene lacustrine river formation of Lake Sevan mead it possible to provide: 1.magnetic and palaeomagnetic characteristics of subdivisions of Pliocene Pleistocene 2.to determine the direction and intensity of the ancient geomagnetic field; 3. to make up the summary of Magnetostratigraphy section of the Pliocene - Pleistocene.This scale which contains 7 directly and 6 inversely magnetized zones.

Keywords: paleomagnetism

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ASI002 **Poster presentation** **3043**

Geomagnetic and geological events

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The Eocene Oligocene border is the time of great geological events of global scale in a history of Cenozoic era. The analysis of geological - geophysical processes on Eocene Oligocene border is carried out according to the data of the two sections and hole in the vicinity of Lanjar village (Armenia). Here late Eocene clays pass into sandstones and into aleurolites of Oligocene. On magnetization (In), size magnetic susceptibility () and magnetization of saturation (Irs) sandstones of Oligocene on the order surpass the appropriate parameters of clays of late Eocene. The ferromagnetic fraction of clays is submitted by magnetite and titanomagnetite, and at sandstones - by magnetite and titanomaggemite. Late Eocene clays are magnetized inversely, and Oligocene part of a section is characterized by a normally magnetization. Here one zone of inverse magnetization is allocated. Such differentiation on Eocene Oligocene border, in all probability is caused with the change of sedimentation process regime. The summary Magnetostratigraphy scale of paleogen of Armenia is made. In late Paleocene the magnetic field was basically reverse. The reverse polarity with short-term levels of direct polarity continued to exist in early and middle Eocene. In the beginning of late Eocene a prevailing role made the direct polarity. Late Eocene is finished by rather great chron of inverse polarity, the roof of which coincides with Eocene Oligocene border. Since of lower Oligocene, the reverse polarity of a magnetic field was again dominant. Values of palaeointensity of a geomagnetic field (H) are divided to two groups. In the first group (early - middle Eocene) the H are near to present values, and in the second group (late Eocene - early Oligocene) these values are much less of present. In this period in territory of Armenia there were rather sharp changes of many faunistic and floristic groups. Rough volcanism, shown in late Eocene, by the end of this time is reducing. In early Oligocene areas of the development volcanosity and its intensity continue to decrease. Since Oligocene Armenia enters in orogenic stage of tectonic development. In connection with transgression of the sea on the territory of the areas with a continental climate in early Eocene are reduced. A wide circulation of tropical and subtropical vegetation testifies to the humid, tropical climate of early - middle Eocene. The late Eocene climate is defined as variably - damp with the tendency to aridity. In early middle Oligocene the essential fall of a thermal mode is marked. All this researches shows, that it is the horizon, in which the reorganization of paleogeografical situation and biosphere of region, and also the regime of magnetic field of the Earth.

Keywords: eocene oligocene

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ASI002 **Poster presentation** **3044**

Constraining the timing of southern Central Andes vertical axis rotations

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A pattern of vertical axis tectonic rotations has been paleomagnetically identified along the Central Andes. While such rotations are counterclockwise in central-northern Bolivia, Per and extreme northern Chile, they are clockwise in southern Bolivia, northern Chile and northwestern Argentina. Various models have been proposed to explain this pattern and the geodynamic evolution of the Central Andes, but the driving mechanism of these rotations remains controversial. Constraining the spatial variability and the timing of the rotations may contribute to a better understanding of their origin. Our study complements information from previous research, improving the knowledge of tectonic rotations in the region of the northern Argentine Puna and the southern Bolivian Altiplano. In Casa Colorada (22.32 S66.29W) 51 cores were drilled from the Pea Colorada Formation. Another 47 cores were collected from Pea Colorada Formation in Paicone (22.20 S66.40W). Pea Colorada Formation corresponds to Eocene to lower Miocene thick fluviatile redbed deposits. The ~17 Ma Casa Colorada dacite dome complex and the basal member of Tiomayo Formation (~16 Ma), which unconformably overlie redbeds from Pea Colorada Formation in Casa Colorada area, were paleomagnetically studied previously. In our previous study, we found that such units do not show significant vertical axis rotations. Furthermore, Upper Miocene (10 Ma and younger) ignimbrites, which overlie these middle Miocene rocks, are unrotated. In the Bolivian Altiplano, close to the international boundary (22.12 S66.40W), 23 cores were drilled from the Esmoruco Formation. The 17 Ma Torrelaire tuffs overlie the redbeds from Esmoruco Formation. Preliminary results of our paleomagnetic study suggest that the sampled zones underwent 13-30 clockwise vertical axis tectonic rotations. Considering the previous studies mentioned above, these rotations should have occurred before approximately 16-17 Ma, imposing a new time constraint to the rotational history of this portion of the Altiplano-Puna. The main fault in the study area is the west-verging San Vicente Thrust. On the basis of a local unconformity observed in the northern Puna, it was suggested that the motion of this fault stopped between 18 and 15 Ma. Then, major activity in the San Vicente Thrust pre-dates Casa Colorada dacite dome complex, the basal member of Tiomayo Formation and Upper Miocene ignimbrites, which do not show significant vertical axis rotations. On the other hand, the clockwise rotated Pea Colorada and Esmoruco Formations should have been affected by the San Vicente Thrust motion. This analysis would suggest the existence of a probable, direct relationship between timing of significant rotations and timing of local deformation in the southern Central Andes.

Keywords: central andes, vertical axis rotations, timing

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ASI002 **Poster presentation** **3045**

Palaeomagnetic data of Lower Jurassic marine strata from west-central Argentina: a new Jurassic Apparent Polar Wander Path for South America

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Alberto Carlos Riccardi, Silvia Elisabet Singer

The study was carried out in four sedimentary marine sections of Lower Jurassic age from the Neuqun Basin in west-central Argentina. Sampled sections are several hundreds meters thick and consist mostly of ammonite-bearing beds with intercalated coeval volcanics. Sampling levels were dated on the basis of the well-studied biostratigraphic record which is correlatable with the International Standard Zonation. Thus, two magnetic components carried mostly by titanomagnetites were identified, one soft that coincides with the present-day local field, and another that is removed at higher temperatures/fields bearing a direction that is clearly distinct from any other of younger age. Coupled with several positive field tests for palaeomagnetic stability and optical analysis, our palaeomagnetic data would indicate that the latter corresponds to the primary magnetisation of the sections acquired during or shortly after the deposition (cooling) of the sedimentary (volcanic) rocks in the Early Jurassic. Two palaeomagnetic poles were thus obtained, one for the Hettangian-Sinemurian (223E, 51S, A95= 6, N = 25) and the other for the Pliensbachian- Toarcian (67E, 74S, A95= 5, N = 52). Using these and other paleopoles in the literature, an APW path for stable South America was constructed for the Late Triassic- Jurassic interval that reflects large apparent polar wander during the Early Jurassic. This clearly contradicts former geodynamic models that depicted the continent in a quasi-stationary position throughout the Mesozoic. This significant latitudinal displacements are observed in other blocks from Pangea as well, such as Eurasia. With these palaeomagnetic poles, minimum drift rates and palaeolatitudes of the Neuqun Basin were calculated. They indicate that South America was located respect to the present-day position, quite farther to the south during the Late Triassic-lowermost Early Jurassic, moved northward at about 20 cm yr 1 by the middle Early Jurassic to finally reach a present-day position by the end of the Early Jurassic. These latitudinal movements recorded in different blocks from Pangea agree with displacements of marine faunas from South America and Eurasia.

Keywords: jurassic, argentina, palaeomagnetism

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ASI002 **Poster presentation** **3046**

Paleomagnetism of Permian red beds in Punta del Viento, eastern flank of the Sierra de Umango, La Rioja, Argentina: the Paganzo basin revisited

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Leonardo Daro Escosteguy, Carlos Oscar Limarino

A preliminary paleomagnetic study was performed on Permian red beds of Patqua/La Colina (PLC) Formation, the youngest unit forming the infill of the Upper Paleozoic back-arc Paganzo basin in central-western . Eight sampling sites were obtained in medium and fine-grained red sandstones cropping out in Punta del Viento (29o7'S, 68o33'W). We found a pattern of variation in magnetic properties along the sequence which condenses in an only place the properties observed in many different, well known sections of Paganzo basin. This allowed us to construct an integrated column for PLC Formation, where all sites are characterized by hematite as the only magnetic carrier, and a reversed-polarity magnetic remanence. The column integrates as follows:1) A lower section with higher intensity of natural remanent magnetization (NRM ~20-40 mA/m), which coincides with the lower member of the PLC Formation, composed of fluvial deposits with some intercalations of alkaline basalts, dated to the earliest Permian (~295 Ma). Paleomagnetic studies of this section have been reported from Las Mellizas, Huaco and Lower Los Colorados.2) An upper section with lower NRM (~1-8 mA/m), corresponding to the upper member of the PLC Formation, characterized by aeolian rocks and ephemeral lake deposits marking the aridization of the region. Stratigraphic relations and palynological assemblages point to a Middle-Late Permian age, which makes these deposits coeval with ignimbrites, rhyolites and dacites of Choiyoi Group, being deposited at that time in the arc-related basins to the west. However, the all-reversed character of the upper section constrains its age to older than 265 Ma, the end of the Permo-Carboniferous Reversed Superchron (PCRS). The upper section of PLC Formation has been paleomagnetically studied in Upper Los Colorados, Paganzo town, Cerro Colorado and Chancan.Paleomagnetic poles reported for both sections are clearly different. The lower section provided a pole position coincident with Late Carboniferous-Early Permian poles for Gondwana, while the upper section poles are departed from this position. We have found evidence to discard local rotations about vertical axis and remagnetizations to explain the departure, and we therefore preferred to interpret the Middle Permian poles as due to apparent polar wander (APW) in a ~30o counter clockwise rotation of the region, after deposition of the Early Permian lower section. The minimum age of 265 Ma for the upper section forces the apparent polar wander (APW) to be rapid.The period of rapid APW would coincide with reported block rotations in the arc-related basins, and with widespread remagnetization in Precordillera, all of which indicates a significant tectonic event. Permo-Triassic Choiyoi volcanics in the arc, and aeolian Middle Permian sediments of PLC upper member in the back-arc Paganzo basin, both postdate the referred tectonic event, which is therefore tentatively placed on 280 Ma.

Keywords: permian, red beds, argentina

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ASI002 **Poster presentation** **3047**

Paleomagnetic and AMS results of Late Triassic red beds, CAMP-related lava flows and Lower Jurassic limestones from Argana Basin, Morocco: geodynamic implications.

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Juan Jos Villalan, Alicia Palencia-Ortas

Palaeomagnetic and AMS (anisotropy of magnetic susceptibility) studies have been carried out in three different lithologies from tectonostratigraphic sequences from the Argana Valley, Western High Atlas of Morocco. The sampled succession consist in (i) Late Triassic (Norian) red beds, (ii) T-J boundary associated CAMP lava flows and (iii) Lower Jurassic limestones (180 oriented samples analyzed). AMS reveals well-defined fabrics that are interpreted in terms of tectonic stresses and/or paleocurrent (magma) flow directions. Detailed, complete, both thermal and Alternating Field demagnetizations have been performed in each section/lithologie. Red bed samples are affected by a remagnetization of normal polarity and unblocking temperature (Tub) around 570C, followed by a high Tub hematite component (of mixed polarity, mostly reversed) that is thought to be of Norian age. Lava flows samples display up to three directional components and different magnetic properties reflecting a variable degree of alteration in concordance with the respective AMS results. Limestone samples also evidence a secondary directional component (of normal polarity and lower Tub and coercivity values than the red beds) followed by a mixed polarity component that is considered as a primary one. To constrain the remanences acquisition times and the possibility (amount/timing) of vertical axis rotations, the mean directions of these distinct components and lithologies, before and after the (Alpine) tilt corrections, are compared with the expected ones derived from the available paleogeography reconstructions of Gondwana and its reliable paleopoles. It results on different possible reconstructions of consecutive events according with the geodynamic evolution of the N-W Africa since the Early Mesozoic.

Keywords: remagnetizations, morocco, geodynimics

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ASI003 **3048 - 3067**

Symposium
Magnetic dating on all time scales

Convener : Dr. Cathy Batt
Co-Convener : Dr. Elisabeth Schnepp

This session will address a broad range of magnetic dating problems. Characteristic time variations of the Earths magnetic field provide dating tools applicable to geological and archaeological structures, and these have been widely exploited. Apparent polar wander paths, the geomagnetic polarity time scale, geomagnetic excursions, and secular variations including paleointensity demonstrate changes on time scales from millions of years to centuries and less. Rock magnetic properties of sediments can also provide useful regional age constraints, and cyclic correlations to the astronomical time scale. The basic requirement for a dating tool is a variation curve or reference model that can be used to match the temporal evolution of the feature or parameter from undated material. Contributions are invited on the use of any aspect of the geomagnetic field for dating on any timescale, including the development of new databases and reference curves. Presentations on new methods for curve and model construction, and techniques for evaluating the reliability of both reference models and the dates attributed by correlation to existing records are particularly welcome

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ASI003 **Oral Presentation** **3048**

Paleomagnetic comparisons of late Pleistocene sediment records

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We report a comparison between magnetic and paleomagnetic results from sediments cores obtained from Tuzla, Pekla and Roxolany sections. These sections are situated in the western and northern parts of the Taman peninsula (S. Russia) and the eastern bank of the Dnistre estuary (Ukraine). The age of the Tuzla deposits ranges between ca. 120 and 10 ka BP, the Pekla deposits between ca. 240 and 60 ka BP and the Roxolany deposits between 340 and 5 ka BP. Rock magnetic properties show a uniformity in terms of magnetic mineralogy, concentration and grain size of the main carrier of the NRM, suggesting that the rocks of these sections may be suitable for relative paleointensity studies. Curves of the geomagnetic field variations (angle elements and paleointensity) are obtained and compared with each other. We have used wavelet and Time Spectral (TSA) analyses to examine the periodicities of the relative paleointensity and angle elements of the geomagnetic field preserved in the Tuzla (120-70 ka), Pekla (240-130 ka) and Roxolany (300-180 ka) sequences. There is a good correlation between the behavior of angle elements of the Tuzla and Roxolany sections with an accuracy of several thousands years. The sharp change in the NRM direction during ~35-30 ka in the Roxolany section is interpreted as the record of the Mono Lake geomagnetic excursion. The same anomalous behavior of the geomagnetic field is likely to have been recorded in the terrestrial loess-paleosoil part of the Tuzla section. Furthermore, two sharp swings of Incl during 110-108 ka including the normal polarity gap are found in a marine lagoon sequence of the Tuzla section. Comparable behavior of the remanence preserved in the lower part of the loess-paleosoils of the Roxolany section is seen only in two sharp deviations of Incl at 99 ka and 106 ka. The stratigraphic position of the geomagnetic reversal sequence in the Tuzla and Roxolany sections, a flip-flop-like behavior of the Earth magnetic field, and the coincidence in time, suggest that we may attribute the recorded anomalous directions to the Blake polarity event. This research was supported by the INTAS Postdoctoral Young Scientists Fellowship grant no. 03-55-2310 and RFBR grant no. 06-05-64200.

Keywords: sediments cores, curvesofthegeomagneticfie, geomagnetic excursion

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ASI003 **Oral Presentation** **3049**

Evaluating archaeomagnetic dates using prior information as part of a Bayesian model. an archaeological case study

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Dr Mark Hounslow, Dr Alex Bayliss, Ben Ford, Steve Teague, Paul Linford

More recent archaeomagnetic determinations (ie within the last 200 years) can be independently corroborated against direct observation of the changes in direction of the Earth's magnetic field. For periods before this, calibration of the directional fluctuations must be sought through other independently dated deposits. Often this is achieved through both absolute and relative dating methods (i.e. dendrochronology, radiocarbon dating, pottery/coin artifacts). This case study presents the correlation of a dataset of 17 archaeomagnetic-dated hearths from Saxon Winchester in the with an independently (i.e. stratigraphically and artefactually) derived relative chronology. As well as significantly adding to the Saxon dataset in the , the stratigraphic relationships from the site are of key importance in modelling the dataset. The stratigraphic prior knowledge is used as part of a Bayesian approach (through the program OxCal v3.10) to model the dataset. This at once provides an independent check on the accuracy of individual dates and increases the precision of the sequence. The Bayesian approach is of key import for the archaeological interpretation of the site; it allows the interrogation of aspects of the chronology, specifically the ordering of events in the absolute, archaeomagnetic chronology of the site with regard to known historical events. This approach allows a qualitative assessment of the archaeomagnetic-derived chronology and a move beyond approaching determinations as simple 'dates in time'

Keywords: archaeomagnetic dating, archaeology, calibration

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ASI003 **Oral Presentation** **3050**

Bayesian archaeomagnetic dating: The RENDATE software

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Dufresne Philippe

The Bayesian statistical framework allows us to estimate the calendar dates of undated archaeological features (such as kilns or ceramics) based on one, two or three geomagnetic parameters (inclination, declination and/or intensity). The "RenDate" software now allows the date estimates to be presented in much the same way as those that arise from radiocarbon dating. It is also possible to combine different datings owning to one or several stratigraphic sequences. In order to illustrate the models and inference methods used, we will present results combining magnetic data with chronometric data (radiocarbon or thermoluminescence dating), relative dating (stratigraphy) and chrono-correlation information (chrono-typology for instance). The important notion of Bayesian phase, or how to define a time distribution for some set of events, will be introduced. The RenDate software will be presented and used to show the models and results we can construct and obtain when it is applied to archaeological data.

Keywords: archaeomagnetism, dating software, bayesian modelling

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ASI003 **Oral Presentation** **3051**

Relative paleointensity studies in sediments from the peri-antartic margins: applications to dating of pleistocene sequences

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Records of relative paleointensity variations (RPI) of the earth magnetic field provide an original stratigraphic tool to solve chronological uncertainties in deep sea sedimentary records of the Southern Ocean south of the polar front. In fact, sedimentary sequences from peri-Antarctic margins have been often neglected from paleoceanographic studies because Antarctic deep and bottom waters are corrosive with respects to biogenic carbonate, and the resulting stratigraphy is deprived of the paleoenvironmental and age proxies derived from the stable isotopes composition of oxygen and carbon in foraminiferal skeletons. In this context, relative paleointensity studies may provide experimental constraints to develop high-resolution age models, to which refer the occurrence of geological and climatic events as recorded in the sedimentary sequences deposited in peri-Antarctic basins. In this talk, we will present a review of the RPI data available for various sedimentary cores collected at different locations (Pacific margin of the Antarctic peninsula, Wilkes Land Basin) along the peri-Antartcic margins, spanning different intervals of the Brunhes normal polarity Chron. We will discuss the problems and the achievements in addressing chronostratigraphic problems in the studied sequences and the procedures for the building of regional reference RPI curves by stacking RPI records from individual cores. We will finally show that the high-resolution age models developed on the basis of the RPI records point out the presence of climatically-driven changes in the magnetic mineralogy. The available evidence suggests a different stability of the West and East Antarctic ice sheets during the climatic cycles of the Late Pleistocene.

Keywords: relative paleointensity, paleomagnetism, paleomagnetic dating

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ASI003 **Oral Presentation** **3052**

A New Approach to Archaeological Dating Using Geomagnetic Field Modelling.

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Richard Holme

In the standard archaeomagnetic dating procedure, both the data used to construct the reference curves and the data from the sample to be dated are reduced to a central location (e.g. Meriden (52.43N, 1.62W) for the UK curve). This procedure assumes for directional data an inclined axial dipole configuration of the magnetic field (reduction via a virtual geomagnetic pole (VGP) (Noel & Batt, 1990), and the same for intensity data, unless no associated directional data exist, in which case a geocentric axial dipole (GAD) has to be assumed. However, the field is not simply dipolar, so this reduction introduces errors into both the reference curve and the particular date determined. Furthermore, the construction of separate curves for each field element ignores an important constraint: the field elements D, I and F are not independent. The aim of this project is to improve on this already successful technique, by using a radically different approach where we build a magnetic dating tool using field modelling. This spherical harmonic model of the field as a function of time will yield master curves of declination, inclination and intensity specifically for the archaeological site of interest. Korte and Constable (2005) have recently developed a global geomagnetic field model (CALS7K) from archaeomagnetic data covering the last 7000 years, but their model is not designed or appropriate for archaeomagnetic dating. We are developing and applying modelling methods specifically aimed towards the generation of archaeomagnetic master curves, supported by targeted data collection to improve modelling constraint, initially for the UK and then expanding to Western Europe. This method also allows data from much greater distances than has been considered previously to be used to constrain a master curve. Preliminary method development using secular variation curves as data shows that by relaxing the smoothness constraints on the model, we can fit the data better than CALS7K and show that this dating technique is viable. This also allows us to consider to what extent different master curves are consistent with each other.

Keywords: archaeomagnetism, geomagnetism, field models

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ASI003 **Oral Presentation** **3053**

Palaeomagnetic, rock magnetic and low field AMS investigations on the Proterozoic dykes of Bundelkhand Craton: constraints on their age and mode of emplacement mechanism

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We report a palaeomagnetic, rock magnetic and low field AMS investigation on NW - SE oriented 24 dolerite dykes, which are traversed into the Bundelkhad Craton. Our palaeomagnetic investigations comprising of detailed AF and thermal demagnetizations on 145 magnetically oriented block samples (around 1100 specimens), have yielded an high quality and statistically significant ChRM direction as D= 126; I= -33 (α95=9.25; N=24 dykes/sites). The secondary components, showing northwest to northeast declinations and intermediate to steep inclinations, are observed in 20% of the studied samples. These secondary components are interpreted as the result of Deccan basalts induced remagnetizations or due to the strong PEF component which are not completely erased by the AF/thermal demagnetizations. A virtual geomagnetic pole (VGP) is calculated by using the isolated primary component (ChRM) direction and is noted as 44.97N; 350.15E (A95=10.06). The obtained VGP, grouping well with the Late Archaean Indian poles, represent 2150 Ma pole from the Indian Shield. The isolated unique ChRM direction from these dykes demonstrates a single magmatic event for these NW-SE trending dykes of the Bundelkhad Craton. The rock magnetic studies, comprising of low and high temperature susceptibilities, Lowri-Fuller tests, Isothermal remanent magnetizations and Q-ratios, confirm magnetite of SD/PSD type is the major magnetic mineral carrying the ChRM component in the studied dykes samples. The low field AMS measurements on 1484 specimens have yielded well defined Kmax, Kint, Kmin principal magnetic susceptibility axes. The mean magnetic susceptibility ranges from 0.8 to 30.7 x 10-3 SI with a mean at 13.3 x 10-3 SI units, indicating the dominance ferromagnetic mineral contribution to the AMS parameters. The average lineation (L), foliation (F) and degree of anisotropy (P') are 1.008, 1.0064 and 1.015 respectively, which are equivalent to the global averages of the mafic intrsive bodies. From the lineation (L) versus foliation (F) diagram it is noticed that grains shapes were biased towards oblate than to prolate. The magnetic foliation planes, defined as the great circles joining the Kmax and Kint axes, are found parallel to sub parallel to the dyke planes, whereas, Kmin axes are nearly perpendicular to the dyke planes. This typical behavior of the magnetic foliation planes, which are observed in the 70% of the studied dykes, represent normal fabrics, indicating the magma flow directions. Kmax vectors of these normal fabrics dykes exhibit declinations from 85-190 and inclinations ≤ 30, demonstrating that the dykes were fed by south-eastward directed horizontal to sub-horizontal magma flows.

Keywords: palaeomagnetism, rockmagnetism, bundelkhand

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ASI003 **Oral Presentation** **3054**

Establishing a secular variation curve for Romania: recent research and a case study dating a roman Kiln complex

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Dr. Cathy M. Batt

This paper will present recent achievements in the construction of a secular variation reference curve corresponding to the territory of Romania. Prior to the research reported here no significant data existed for this large territory in Eastern Europe and so it was impossible to define the local secular variation of the earths magnetic field. As a result this research aims to recover as much data as possible from archaeological contexts currently being excavated. Several sets of features and archaeological sediments have been sampled during the 2005 and 2006 field seasons and the results of their analysis are summarised and compared with the published directional data from Bulgaria, Hungary and Ukraine. Our procedures will be illustrated using the case study of two Roman pottery firing kilns belonging to an officinae complex discovered in the general hinterland of the two Roman towns at Apulum (nowadays Alba Iulia), following a rescue excavation. Series of samples have been collected from various areas of the kilns and details from the analysis and their combined results will also be presented. The samples were subjected to alternating frequency demagnetization for directional studies and IRM acquisition analysis was performed using the available facilities in Alba Iulia. The kilns were also dated using the available archaeomagnetic data from the region and the result showed good agreement with the archaeological estimate, provided by two coins found within each of their infill.

Keywords: romanian calibration curve, directional dating, kiln complex

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ASI003 **Oral Presentation** **3055**

Placement of the Frasnian-Famennian (Upper Devonian) extinction event and boundary within the XOM NHA section, Middle Vietnam, using new biostratigraphic (CONODONT) and magnetostratigraphic

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Brooks B. Ellwood, Ta Hoa Phuong, Dr. Eberhard Schindler

We have measured the magnetostratigraphy susceptibility (MS) for 147 samples collected at 5 cm intervals over 7.3 m,extending across the Frasnian-Famennian (F-F) boundary interval within the Xom Nha Formation, Quang Binh, Middle Vietnam.Biostratigraphic control for high-resolution chronocorrelation is provided by conodont zonation. The Conodont data show that the F-F boundary lies within the lower part of the Xom Nha Formation, between the linguiformis Zone, that ends within limestone Bed 9, and the triangularis Zone, beginning in Bed 10. MS data from Xom Nha samples are correlated to the well-known La Serre Trench C section, located in southern France near the Coumiac F-F GSSP and chosen as the magnetostratotype for the boundary by Crick et al. (2002), and to the type Kellwasser locality located in the Harz Mountains in Germany. Based on MS trends within both the La Serre and Harz Mountain Kellwasser sections,the MS data are consistent with placement of the F-F boundary in the Xom Nha section within the lower part of Bed 9. Crick, R.E., Ellwood, B.B., Feist, R., El Hassani, A., Schindler, E., Dreesen, R., Over, D.J., and Girard, C., 2002, Magnetostratigraphy susceptibility of the Frasnian/Famennian boundary. Palaeogeography, Palaeoclimatology, Palaeoecology, 181, 67-90.

Keywords: magnetostratigraphy, susceptibility, f fboundary

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ASI003 **Oral Presentation** **3056**

CHronology of the final marine regression in the eastern Ebro Basin (Eocene-Oligocene, NE Spain).

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The Ebro Basin (NE Iberian Peninsula) is a triangular shaped basin surrounded by three alpine ranges: the Pyrenees to the north, the Iberian Range to the SW and the Catalan Coastal Range to the SE. The basin is the latest evolutionary stage of the South-Pyrenean Foreland Basin. This foreland basin evolved from Late Cretaceous to Miocene by flexural subsidence related to the growth of its margins because of the continental collision between the Iberian and European plates. Connection of the Ebro Basin with the open sea was maintained until late Eocene, when ongoing convergence along the Pyrenean margin lead to the final closure of its western connection with the Atlantic Ocean. Since then, a long endorheic period of uninterrupted continental sedimentation leads to the accumulation of a thick sequence composed by alluvial and lacustrine facies. Youngest deposits in the central Ebro Basin are dated as late middle Miocene. The age of the youngest marine deposits in the Ebro Basin is approximately constrained to the Upper Eocene (late Bartonian to Priabonian) based on biostratigraphic markers (shallow benthic foraminifera and nannoplancton). Age constrains for the overlying continental sediments are limited to a classical mammal fossil site (Sant Cugat de Gavadons) which yielded a late Eocene age (MP 19 mammal age), while younger units yield abundant Oligocene fauna. Previous magnetostratigraphic studies focused on the marine sedimentary units have generated contrasting results and have not provided robust conclusions on the timing of the final marine regression in the Ebro Basin. In order to better restrict this chronology, we have sampled for magnetostratigraphy two 700 m- thick continental sequences spanning the late Eocene-Oligocene. Samples were collected at 2-5 m stratigraphic intervals. Stepwise thermal demagnetisation of the NRM of up to 2 samples per site has yielded a local magnetic polarity stratigraphy. Unambiguous correlation with the geomagnetic polarity time scale was feasible based on the presence of late Eocene to early Oligocene mammal fossil localities and previous magnetostratigraphic studies spanning the complete Oligocene stratigraphic record. Conclusions of this study provide with reliable age constrains for the marine-continental transition and helps understanding the Late Eocene to Early Oligocene sedimentary evolution of the eastern Ebro Basin.

Keywords: eocene oligocene, ebro basin, magretostratigraphy

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ASI003 **Oral Presentation** **3057**

Cyclostratigraphy of the core and well data log from a bore-hole in upper cretaceous reworked carbonates

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Andrea Albianelli, Maria Teresa Galli, Maria Rose Petrizzo, Isabella Premoli Silva, Antonio Valdisturlo

Well data logs from a drilling bore-hole in Late Cretaceous carbonates of Scaglia facies from the external Apennine domain are associated with bio- and magnetic- stratigraphy for reconstructing the ages involved in the subsurface geology, previously insufficient in providing a fine resolution.A nearly 200 m thick core of generally resedimented (turbiditic) deposits but with frequent short hiatuses provide records of microfossil and magnetic signals that reveal a chronostratigraphical zonation.The recognized 7 magnetozones are calibrated to chrons 33 to 31 of the geomagnetic polarity time scale, for a time span of nearly 9 my, that includes the biostratigraphical ages from mid-late Campanian at the base but not reaching the K/T boundary at the top. Essential to the estimation of dates for fixing stratigraphical resolution was the magnetic cyclostratigraphy through the core, where the polarity reversal sequence showed important changes in the sedimentation rates. The highest changes occur in the middle of the core, where the magnetic zonation is resolved evaluating the cycle lengths in the susceptibility record through a 32.5 m thick profile, which produced for it a duration of 1.3 my. Actually, this is an interval of changing sedimentary regime, which could be resolved by means of spectral analysis of the continuous magnetic record, in cycle whose duration is assigned on the base of the magnetostratigraphical constraints. In fact thick portions of the core are confined within magnetochrons of a too short duration and viceversa, so that a significantand sharp change can be reasonably implied.A decisive confirmation on the high resolution obtained in the magnetically analysed shor core was provided by the highly detailed logs of several physical properties. The one here reported was the microresistivity signal, processed with the same cyclostratigraphical treatment as for the magnetics. Their matching paths through the common intervals represent the response to the same forcing signal of the astronomical parameters on the climate changes. This cyclic microresistivity record has been calibrated for the whole core, and thence its further extension to the unrecovered portion of bore-hole has become viable. The induced cyclicities are of Milankovian type, and extend to the end-Cretaceous the similar ones demonstrated for the mid-Cretaceous Black Shales of the Gubbio sequence in the Scaglia of the Umbrian Series.

Keywords: magnetostratigraphy, cyclostratigraphy, well logs

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ASI003 **Oral Presentation** **3058**

Calibration of the continental sediments from the upper Valdarno Basin to the Plio-pleistocene as a tool for correlating the apennine continental sequences

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The continental sequence of the Upper Valdarno Basin consists of nearly 500 m thick lacustrine and fluviatile sediments, magnetostratigraphically calibrated to the Gauss and Matuyama chrons and dating nearly 2.5 my. Their deposition was interrupted by two major pulses in the uplift of the Apennine Mountain Belt, onedated at the boundary of the Gauss/Matuyama chron and the other at shortly after the Olduvai chron. Such interruptions are differently recorded, the former by a condensed sequence containing the Gauss/Matuyama boundary and the short normal chron of the Reunion and the second by lack of any record. The initial deposition was rapidly of lacustrine sequences filling the basin since the Mammoth at 3.3 Ma, with uniform silty clays dating from 3.15 Ma, shortly before the Kaena, through the latest Gauss. This time span was separately measured by its spectral content of the continuous magnetic signal to last 400 ky, within which a bimodal cyclicity was identified to occur at 2.85 Ma. At the same time, the curve of the pollen distribution started moving towards a reduction of species of the subtropical forest and an increase of the altitudinal coniferous vegetation; thereafter, an oscillating pattern from open to forestvegetation took place in the early Matuyama. In the second lacustrine cycle the record is less continuous and the highest percentage of herbs reached at nearly the P/P boundary. The vertebrate fossil record contains the key Villafranchian faunas, from the Triversa Faunal Unit of the Villafranca d'Asti sequence of north-western Italy to the Pirro faunas of southern Italy, with their biochronological ages stratigraphically distributed in dates by means of the magnetostratigraphic calibration to the Gauss and Matuyama chrons. The earliest Villafranchian fauna is dated 3.15 Ma and the succeding Montopoli fuana of the Lower Valdarno, the only fauna dated before the calibration of the Upper Valdarno sequence, at 2.58. The other faunas included in the Villafranchian, ranging from the Olivola F.U. of the north-western Apennines to Tasso of the Upper Valdarno and Farneta in central Apennines up to Pirro approached the P/P boundary or just passed it, but were little affected by the major global changes, which occurred at the critical time. After the Villafranchuian age, the new fauna started to build the asset of the present day distribution at the end of the Matuyama, and possibly at the boundary with the Jaramillo chron. The Mammal Neogene (MN) age units MN16a MN16b and MN17 of western Europe are therefore dated with the Geomagnetic Polarity Time scale.

Keywords: magnetochronology, paleoclimate

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ASI003 **Oral Presentation** **3059**

Archeomagnetic reference curves for the Iberian Peninsula

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A first secular variation (SV) curve for the Iberian Peninsula, computed by hierarchical Bayesian method using a total of 134 archaeomagnetic directions (from 775 BC to 1959 AD) was recently published (Gmez-Paccard et al.,Geochem.Geophys.Geosyst.,7,Q12001,doi:10.1029/2006GC001476, 2006). This SV curve extends the archaeomagnetic dating technique to Spain and Portugal. As a reference curve of the field intensity time variations would be also useful for archeomagnetic dating of pottery and displaced archeomagnetic objects, we have also determined the paleointensity of the geomagnetic field on 24 Spanish archeomagnetic sites, with ages ranging from 220 AD to 1959 AD. The classical Thellier technique was used with anisotropy of thermal remanence and cooling rate corrections. Our new data, together with 62 previously published archeointensity results, were used to recover, by Bayesian modelling, the geomagnetic field intensity evolution over the past two millennia for western Europe. The Bayesian archeointensity curve obtained is not very well constrained for High Middle Ages. More data are clearly needed before to be able to use archeointensity curve as a dating tool.

Keywords: spain, secular variation

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ASI003 **Poster presentation** **3060**

Variation of archaeointensity in East Siberia and their using for revision of the dating multilayered archaeological sites

Prof. Konstantin Burakov

Nachasova Inga

Investigation of magnetization of ceramic material from cultural layers in archeological sites Gorely Les and Ust-Hayta (Irkutsk area), dated by time-interval V millennium BC - I millennium AD, was undertaken for the reason increase the volume of data about the intensity of ancient geomagnetic field for Siberia region. The received data located on time scale according to archeological dating, have found the observable divergence on row time-intervals. The intensity of geomagnetic field, got on material of the under-stratums site Gorely Les and Ust-Hayta, practically alike that confirms archeological dating the initial cultural layers of the sites. The age upper layer of site Gorely Les is determined at 1500 years approximately. Length of existence of the settlement Ust-Hayta is not determined. Dating the layers both sites contains the essential uncertainty. When undertaking the previous investigation of ceramic material from various multilayered archeological sites in Euro-Asia (Caucasus, Central Asia, Mesopotamia, Spain) authors to advantage used the methods an layer-by-layer selection of the ceramic material from cut of the layers, composing archeological sites, for construction the picture of archaeointensity variation. The time of accumulation of layer, from which was selected material, was realized by partition the temporary interval, to which is referred all time of existence of the settlement or its determined stage, on length, corresponding to thickness of layer. The velocity of the accumulation of deposits is taken to be constant in the whole considered time-interval. Naturally, this rough approach, but under mentioned accuracy of the dating and comparatively small power of the deposit it wholly possible. Is it in this instance offered variant of the dating the layers in accordance with depth of their location in cut of the deposits with use for checking the data about the archaeointensity. Herewith, were used also data about the intensity of geomagnetic field for temporary interval since III millennium BC till middle of I millennium AD, got earlier as a result of investigations of magnetization of ceramic material from monuments North Pribaikaliya and Priolkhonje, having more exact dating [Burakov and others, 2000]. As a result of synchronizing the layers accordingly depth along cut of the sections of monuments Gorely Les and Ust-Hayta as of from both monument is received non-contradict picture of the change of geomagnetic field on temporary interval V-II millennia BC, that affords ground approve got dating the layers both monument, for several of the layers greatly differing from archeological. Smoothed out 300-annual curve of archaeointensity was constructed on the base of data received on ceramic material from both settlements. The harmonic analysis of this row has shown that picture of archaeointensity variation can be approximated by the sum of long-period (

Keywords: archaeointensity, geomagnetic field variation

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ASI003 **Poster presentation** **3061**

Paleomagnetic dating of the alteration overprint on Jurassic lavas in Central Patagonia: relationship with mineralizing events

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The extrusive flows of a Middle to Late Jurassic volcanic event occur throughout a wide area of southern South America, representing the culminating event of an extensional period that preceded Gondwana break-up. The volcanism in Central Patagonia is characterized by basic to intermediate composition lavas overprinted by a very low-grade metamorphic event. Occasionally the Jurassic andesites are spatially related with polymetallic, Au-bearing, mineralised veins. Some authors have related both the metamorphism, and mineralization, to the activity of low-temperature geothermal systems. A palaeomagnetic study of 24 basaltic-andesitic flows from the Late Jurassic Caadn Asfalto Formation revealed the presence of two magnetic components, both of them carried by magnetite. The harder component (A), with coercive force > 70 mT and unblocking temperature 590oC was interpreted as primary, acquired on cooling of the lavas. In addition, heating up to 350-400oC allowed isolating a softer component (B) in 22 sites, in a consistent direction: Dec. 15o, Inc. -53o, α95 4.8. The acquisition of the component B postdates the tilting of the lavas (negative fold test); however, it differs from the present magnetic field, and therefore a recent viscous origin can be discarded. The uncorrected component B is coincident with the primary remanence carried by the overlying Upper Jurassic-Lower Cretaceous sedimentary sequence (Upper Caadn Asfalto/Caadn Calcreo Formation), and both are rotated respect to the expected Late Jurassic to Recent geomagnetic field for South America. Previous studies have shown that rotation occurred in the earliest Cretaceous, coeval with, and perhaps closely related to the opening of the South Atlantic Ocean. According to the magnetic relaxation time versus blocking temperature curves established for magnetite, to remagnetise the magnetic fraction with blocking temperatures below 350oC would require a metamorphic peak of about 150oC that lasted for a period of about 1 m.y., compatible with the low-grade (zeolite) metamorphic assemblage observed in these lavas. The component B predates the tectonic event that lead to the rotation of widespread areas of Caadn Asfalto basin in the Early Cretaceous; on the other side, the negative fold test indicates that it postdates the tilting of the Late Jurassic flows. That puts the remagnetisation event in a time span restricted to the Jurassic-Cretaceous transition. Because of the potential economic importance of the mineralization it is important to establish the relationship between the remagnetization event and the major tectonic rotations in the area. This relationship would be a valuable exploration guide for the low-sulfidation epithermal systems formed following the volcanism.

Keywords: jurassic, volcanics, low grade metamorphism

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ASI003 **Poster presentation** **3062**

Archaeomagnetic dating of four spanish structures

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Archaeomagnetic studies in Spain have undergone a significant progress during the last years and a reference curve of the directional variation of the geomagnetic field over the past two millennia is now available for the Iberian Peninsula. These recent developments brought us to a situation where the archaeomagnetism can be used as a new dating tool for Spain and Portugal. The aim of this work is to illustrate how this new curve can be used to precise the dating of poorly age constrained archaeological structures. For this purpose, four combustion structures from three archaeological sites with ages ranging from Roman to Medieval have been studied and archaeomagnetically dated: La Fornaca kiln complex, Vila Caputxins and Can Xammar. Samples were taken using a portable electrical drill with a water-cooled diamond bit. About 10-12 samples per kiln were taken randomly oriented through the overall structure (walls, grill, central pillars) and were oriented by the magnetic and/or solar compasses. Remanent magnetization was measured with a superconducting rock magnetometer (2G Enterprises) in the Paleomagnetic Laboratory of Barcelona (SCT UB- CSIC). The directions of the characteristic remanent magnetization have been obtained from classical thermal and alternating field (AF) demagnetization. In all cases, thermal demagnetization was revealed to be more effective than AF demagnetization. 10 to 16 demagnetizations steps, up to 560-570C or 100 mT, were applied to the samples. For most of the samples, we observed a well-defined single component of magnetization directed towards the origin, which likely corresponds to the thermoremanent magnetization acquired during the last firing of the structures. However, for some samples a viscous component was also observed which was usually removed around 200 C. The mean directions of magnetization were calculated using principal component analysis and Fisherian statistics. More than 7 (independently oriented) samples directions have been used in the calculation of the mean site direction. The mean directions obtained were compared with the secular variation curve available for the Iberian Peninsula. The dating procedure consists on calculating the probability density functions of possible dates for both declination and inclination. The probability density functions (obtained from declination and inclination results) are then combined to obtain the most probable solution at one confidence level. This can be done using the software REN-DATE developed by P. Lanos and based on Bayesian statistics. The inferred ages obtained from this study are consistent with the existing archaeological evidences.

Keywords: archaeomagnetic dating, reference curve, iberia

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ASI003 **Poster presentation** **3063**

Initial SCHA.DI.00 Regional archaeomagnetic model for Europe for the last 2000 years.

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The available Bayesian European Palaeosecular Variation Curves (PSVC) based on archaeomagnetic data have been used to derive a regional model for the geomagnetic field in Europe for the last 2000 years by using the Spherical Cap Harmonic Analysis (SCHA) technique. The resulting SCHA.DI.00 model provides the directional behaviour of the Earth magnetic field, but not information about intensity. The first spherical cap harmonic coefficient, g00, has been used to normalise the rest of coefficients. The spherical expansion extends up to k = 2 which, given the size of the spherical cap used, is equivalent, in terms of spatial wavelength, to a degree of approximately 7 in the ordinary Spherical Harmonic Analysis (SHA). In order to constrain the behaviour of the model in the region, data were synthetized for few points at the edge of the cap by iteratively applying simple spherical cap models on the real palaeosecular curves. The SCHA.DI.00 model fits the input data more accurately than global models (Hongre et al., 1998; Jackson et al., 2000; Korte and Constable, 2003, 2005). Palaeosecular variation curves given by SCHA.DI.00 are compared with available archaeomagnetic data from not used in the development of the model, and with the global models. The calculated palaeosecular curves improve the fit to the palaeomagnetic dataset given by the CALS7K.2 model (Korte and Constable, 2005), especially for southern .

Keywords: archaeomagnetism, geomagneticsecularvariation, regionalmodels

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ASI003 **Poster presentation** **3064**

The archaeomagnetic calibration curve of Austria, revisited

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The hitherto existing Austrian archaeomagnetic calibration curve is based mainly on archaeomagnetic directions from sites outside of Austria, situated in Bosnia, France, Germany, Hungary and Switzerland. Meantime more than 50 structures from 15 new sites in Austria and 3 sites in southern Germany have been studied and corresponding, well dated archaeomagnetic directions have been obtained. Furthermore new data from northern Italy are available. The revised data set taken from a 500-km circle around Radstadt (47.38N, 13.45E), comprises now about 250 archaeomagnetic directions with ages ranging from 5500 BC to today. While before 500 BC the data are sparse and concentrated to some short time intervals, later times are well covered with data and allow to calculate a refined archaeomagnetic calibration curve for Austria. This curve will be compared with independent secular variation curves from England, France, Spain and Bulgaria and common features will be discussed.

Keywords: archaeomagnetism, secular variation

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ASI003 **Poster presentation** **3065**

Magnetic polarity time scale of oxfordian through lower Kimmeridgian and calibration of pre-M25 marine magnetic anomalies

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Both the birth of the present Pacific plate and the initiation of spreading in the Atlantic and Indian Oceans began during the Middle to Late Jurassic (about 160 Ma). The signature of the resulting M-sequence marine magnetic anomalies of mid-Jurassic through early Cretaceous in each basin has been successfully calibrated via magnetostratigraphic studies to biostratigraphy and associated geologic stages for the Kimmeridgian through basal Aptian. However, the oldest pre-M25 marine magnetic anomalies, which record the timing and rates of initial seafloor spreading, had remain uncalibrated owing to the lack of a complete and verified magnetic polarity time scale for Bajocian through Oxfordian. We applied thermal demagnetization to over 400 samples from 13 sections within the thick ammonite-zoned Oxfordian-Kimmeridgian limestone formations of the Jurassic Upland and Holy-Cross Mountains in Southern Poland. The data allowed us to create a continuous polarity pattern from Early Oxfordian (Cordatum Zone) to Late Kimmeridgian (Mutabilis Zone). The resulting polarity pattern of about 14 reversals can be correlated and merged with polarity patterns derived from other Sub-Mediterranean ammonite-zoned strata in , and . The composite Sub-Mediterranean magnetic polarity time scale is consistent with an independent polarity pattern derived from Boreal-realm sections of the British Isles that have Boreal and Sub-Boreal realm ammonite zones, and is applied to inter-correlate between these two faunal realms. In addition, the Oxfordian magnetic polarity scale has a corresponding signature in the pre-M25 marine magnetic anomaly sequence that has been interpreted from deep-tow surveys of Pacific oceanic crust. The results confirmed chrons M24a, M24b and M25 in the Lower Kimmeridgian. The consistency of magnetostratigraphic results from Raciszyn (Poland) to those from Isle of Skye and South Ferriby sections in Britain implied that the Boreal-defined base of the Kimmeridgian Stage as defined in the Boreal faunal realm correlates to the Hauffianum ammonite subzone of the Sub-Mediterranean realm, which is approximately 1 million years below the traditional base-Kimmeridgian in the Tethyan faunal realm. This conclusion is consistent with some Boreal ammonites, Amoeboceras bauhini and Pictonia densicostata, that are common to all three sections. The beginning of the Upper-Oxfordian and the Middle-Oxfordian substages as defined in the Sub-Mediterranean province in correspond approximately to chrons M29 and M33 of the Pacific M-sequence.

Keywords: stratigraphy, jurassic, polarity

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ASI003 **Poster presentation** **3066**

On calculations to obtain geomagnetic field models from poorly distributed paleomagnetic data

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It is necessary to use the stochastic approaches in inversion processes (Jackson, 1979; Gubbins, 1983) when we seek the geomagnetic field models from poor distributed and large error geomagnetic and paleomagnetic datasets. However, there are two free factors in the stochastic inversion: kind of given field constraint as a priori information and value of the hyper parameter contributing the ratio of contribution of the constraint in the solution. Here we seek the best hyper parameter with using ABIC (Akaike's Bayesian Information Criteria; Akaike, 1980) which is one of the strategies for the determination and is based on mathematical and statistical objectivity. We test the availability of it in the inversion from synthetic datasets of various site distributions. Enought good solution could not be sought from extremely poor and heterogeneous site distribution. Moreover the solutions sought with different constraints are compared and it is suggested that there is not a large difference in the main properties of the obtained field models between two tested constraints as the prior information.

Keywords: geomagnetic secular variation, inversion method

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ASI003 **Poster presentation** **3067**

Geomagnetic field variation during the past 5000 years: A global reconstruction

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K. Fabian

Recently, a number of studies were dedicated to the investigation of the global geomagnetic field variation over the last several thousand years. These studies were either based on archeomagnetic data or on historical field recordings and provide reference models, which can be used to match undated data. Here, we present a combined analysis of both, archeomagnetic and historic field data in order to obtain a low-degree geomagnetic field model for the last 5000 years.This is accomplished by a Bayesian inversion technique, which minimizes the total variational power at the core-mantle boundary under data constraints. Since the resulting inversion equation is linear, it is fast, easy to apply and very stable with respect to changes in the input parameters. The used data sets comprise fullvector, directional, but also pure intensity data. Since the inversion works reliably even on a smaller base of good data, we carefully selected the input data to include only the most trustworthy. In its basic structure, the finally obtained field evolution scenario is similar to earlier models. However, our technique for the first time successfully reproduces archeomagnetic jerks, which particularly are observed in western Europe. Furthermore, since our inversion method leads to a unique solution and is very fast, it allows for a detailed statistical investigation of the influence of data uncertainties by using a bootstrap type statistical analysis.

Keywords: reference model, bayesian inversion, geomagnetic field

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ASI004 **3068 - 3082**

Symposium
Palaeointensity studies progress and challenges

Convener : Mr. Yongjae Yu, Dr. Yuhji Yamamoto
Co-Convener : Dr. David Krasa

Paleointensity determination has broad applications from geochronology to discussions regarding regimes of convection in the outer core, the growth of inner core, and possibly the evolution of core-mantle boundary. In contrast to our knowledge of the directional behavior of the Earth's magnetic field during geological and historical times, data constraining the past intensity of the field remain relatively scarce. The scarcity originates from the difficulty in finding suitable material and rather narrow range of rock magnetic parameters required for reliable paleointensity work. We are welcoming contributions covering both absolute and relative paleointensity determination in the following broad areas of interest:advances in paleointensity methodology (development of new/optimum techniques), novel high-fidelity paleointensity recorders, discussions on a possible link between paleointensity and reversal frequency, results from extraterrestrial samples, and general contribution to the wealth of data on all timescales

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ASI004 **Oral Presentation** **3068**

Development of the microwave LTD-DHT Shaw method

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John Shaw

Since the 1970s, Thellier-Thellier and Shaw methods have been most commonly used to determine absolute paleointensity. The principles behind these methods are very different and it is important to develop them both. The group at the Tokyo Institute of Technology, Japan, have developed a significantly improved version of the original Shaw method, called the LTD-DHT Shaw method. This method has been successfully applied to several historical lava flows in Hawaii and Japan. The present protocol, however, uses conventional heating by electric ovens for laboratory acquisition of thermal remanent magnetization (TRM), which can cause excessive laboratory alteration that cannot be corrected for. To further enhance reliability, we have replaced the TRM step with a microwave excitation step. Three types of experiment have been performed using the 14 GHz microwave demagnetizing-remagnetizing system in the Geomagnetism Laboratory, University of Liverpool. (1) Microwave LTD-DHT Shaw method on samples with laboratory microwave TRM (TmRM) TmRM (15.0 micro-T) is imparted in 5 mm diameter mini cores of basalt. The applied microwave power is 80 W and the application time is set to 5 seconds. This TmRM is a simulated natural remanent magnetization (NRM). The mini cores are then subjected to the microwave LTD-DHT Shaw experiment. (2) Microwave LTD-DHT Shaw method on samples with laboratory TRM. TRM (25.0 micro-T) is imparted in one-inch cores of basalt. The cores are heated in an electric oven to a maximum temperature of 610 C. Hold time at the maximum temperature is 30 minutes and the entire heating-cooling cycle takes about two hours. This TRM is a simulated natural remanent magnetization (NRM). Mini cores are cut from the one-inch cores, and they are subjected to the microwave LTD-DHT Shaw experiment. (3) Microwave LTD-DHT Shaw method on samples from historical lava flows. Mini cores are cut from the one-inch cores collceted from historical lava flows. They are then subjected to the microwave LTD-DHT Shaw experiment. So far, we have performed four type (1) experiments, all of which were successful, and give an average of 15.2+/-0.6 micro-T. From the type (2) experiments six out of ten were successful and give an average of 24.6+/-1.9 micro-T, excluding one outlier (which had local melt spot during first microwave application). These values are fairly consistent with the imparted laboratory field. Experiment (3) is still in progress and new results from the experiment will also be reported.

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ASI004 **Oral Presentation** **3069**

Absolute palaeointensity determinations on baked materials from a large Roman tile kiln at Hermalle-sous-Huy (Belgium) a case study.

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Jozef Hus, Raoul Geeraerts

Different palaeointensity methods were implemented on baked materials taken in a Roman tile kiln that was discovered in Hermalle-sous-Huy (Belgium) and that is presented here as a case study. This large rectangular kiln (650 m2) was part of an important tile production centre in Roman times, close to the river Meuse. The last kiln operation was archaeomagnetically dated at 127 (34) AD based on the recorded geomagnetic field direction. The NRM directions of individual independently oriented samples are very tightly clustered, as indicated by the Fisherian concentration parameter k that exceeds 16 000, and viscous overprints are nearly absent. Floor and walls show signs of vitrification, indicating that temperatures above 1000 C had probably been reached in the combustion chamber, resulting in well baked massive silty in-situ material surrounding the kiln.The strategy developed in Spassov and Hus (2006) was followed in order to trace mineralogical changes induced during successive laboratory heatings and hence to increase the success rate of intensity determinations. These preceding rock magnetic investigations point to the presence of thermally stable coexisting haematite and maghaemite phases with variable contribution. Different palaeointensity determination methods were tested on different baked materials (in-situ baked silty material, tiles) collected in the kiln, such as the classical Thellier-Thellier (1959) in-field double heating method, the alternating field demagnetisation method of Shaw (1974) and the recently, so-called multispecimen parallel differential pTRM method proposed by Dekkers and Bhnel (2006). The results of the applied techniques will be compared and discussed, and some new aspects of analysis of data obtained by the classical Thellier-Thellier in-field double heating method will be presented.

Keywords: palaeointensity, archaeomagnetism

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ASI004 **Oral Presentation** **3070**

Thellier-type paleointensity determinations from North-West Russia dyke complex of 1450 Ma age

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Shcherbakova Valentina, Lubnina Natalia, Zhidkov Grigory

We report highly reliable Thellier-type paleointensity determinations including pTRM check procedure, obtained from four dykes and baked contacts from North Ladoga, Karelia. Electron microscope observations, thermomagnetic and hysteresis property measurements indicate the presence of PSD TM with low Ti content as the main magnetic mineral. The stepwise AF and/or temperature demagnetization revealed two-component NRM for most of the samples. The ChRM component was isolated in (440-590) C interval. Noteworthy, that the ChRM constitutes most of the NRM intensity up to 95 %. The position of the paleopoles of the ChRM do not contradict the key poles for (1270-1580) Ma time interval reported by Buchan et al., 2000 and Pesonen et al., 2003 testifying anticlockwise rotation of all East Europe Craton at time interval (1.45-1.5) Ga. About 40 samples passed strict criteria of reliability of paleointensity determinations, quite a few of them demonstrate Arai-Nagata diagrams close to ideal straight lines over all temperature range. The site-mean VDMs determined on, vary from 1.93 to 3.74 (1022 Am2). These determinations agree well with the data reported previously by Shcherbakova et al. 2004, 2006 for: South Karelia (VDM = 1.21022 Aм2, 1460 Ma age; VDM = 1.81022 Aм2, 1770 Ma age) and South Siberia (VDM = 51022 Aм2, 1850 Ma age) which also yielded low VDMs. Based on these observations, we speak up for the suggestion of domination of low VDMs in the Proterozoic expressed by Macuoin et al., 2003 and Dunlop and Yu, 2004.

Keywords: proterozoic paleointensity, thellier type, low vdm

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ASI004 **Oral Presentation** **3071**

Absolute paleointensities for recent lavas from East Maui (Hawaii, USA) determined with the multispecimen parallel differential PTRM method

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Harald N. Bhnel, Mark J. Dekkers

We have determined the paleointensity of eight recent lavas flows drilled from the youngest and largest of the two edifices of the island of Maui (ie East Maui) with the multispecimen parallel differential pTRM method (Dekkers and Bhnel, 2006). The flows are characterized by irreversible Curie curves indicating two kinds of magnetic carriers, one almost pure magnetite and the second one Ti-rich magnetite with a possibility of traces of titanomaghemite. The coercivity of remanence (Hcr) suggests that the NRM is carried by low-coercivity grains. All these flows are scattered within the PSD range with exception of site HKAM (age 4.07+/-0.09) which lie in the SD range.The multispecimen method involves giving a laboratory pTRM to pristine specimens in different field strengths parallel to the orginal TRM; note that all pTRM are given from the same temperature. From an existing sample collection for paleosecular variation studies (Herrero-Bervera et al., in prep) we could process 9 flows for paleointensity determination with this protocol ranging in age from 0.830.06 ka to 8.190.06 ka. pTRM were given by cooling from 175C to avoid alteration, susceptibility variation appeared to be less than 10%. Eight flows yielded good quality data, one flow appeared to show erratic and non-interpretable behavior (that flow had a larger susceptibility increase). The paleointensity increases to ~46 microTesla at ~ 2.2 ka whereas it drops to ~22 microTesla at ~3.5 ka, at ~8.2 ka ~39 microTesla is obtained, i.e. slightly higher than present-day values (36 microTesla).

Keywords: absolutepaleointensity, multispecimenmethod

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ASI004 **Oral Presentation** **3072**

The Auckland geomagnetic excursion: paleodirections and paleointensities from five key volcanoes within the Auckland Volcanic Field

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Mimi J Hill

The Auckland geomagnetic excursion is recorded only in basaltic rocks from the late-Quaternary monogenetic Auckland volcanic field (AVF). It provides a rare example of an excursion from the SW Pacific region and therefore can make a valuable contribution to global modelling. Remarkably, the excursion is recorded by several geographically separate volcanoes within the AVF. Five of these show anomalous paleoinclinations spanning only about 5o, estimated to be equivalent to a time span of about 50-100 years, based on documented rates of change of field directions during comparable excursion events. Although previous paleodirectional and age data suggest that the Auckland basalts may have recorded two separate excursion events, this is based on somewhat limited sampling and dating experiments. Existing dates require further independent corroboration before the Aucklandevent(s) can be confidently correlated with any well-established geomagnetic excursion. The first 40Ar/39Ar dating programme for the AVF is currently underway to help resolve some of the previous dating ambiguities. It is proposed here that the term Auckland excursion refer to that event defined by the most concordant and well documented reverse polarity directional anomaly (known formerly as the north-down group of three), whilst other more intermediate directions (with possibly different ages) reported from few sites, be regarded only tentatively as indicating a second excursion event. New paleodirection data show that whilst four of the five volcanoes referred to here exhibit anomalous directions which tightly cluster, the fifth is a marginal outlier, possibly reflecting a small segment of an excursion path. Preliminary paleointensity measurements have been carried out on samples from these five volcanoes using a 14 GHz microwave system (employing both parallel and perpendicular applied field methods) and yield successful results for three of the four volcanoes within the tight cluster, giving paleointensity values of 9-15 μT. These results are consistent with previously reported measurements on three of this group using low temperature demagnetisation methods (LTD-DHT Shaw method), confirming that the dipole moment was about 20% of its normal strength. The fifth outlier volcano appears to record a slightly higher paleointensity of 21 μT, otherwise there is no apparently significant variation in paleointensity amongst the volcanoes, as might be expected from the narrow range of excursion directions recorded.

Keywords: excursion, paleointensity, auckland

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ASI004 **Oral Presentation** **3073**

Preference of normalizer on sedimentary paleointensity: strong influence of magnetostatic interaction on ARM acquisition

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In relative paleointensity estimations, the choice of a parameter for normalizing NRM acquisition efficiency has been a matter of debate. ARM has often been used, mainly because coercivity spectrum of ARM is thought to be close to that of NRM (DRM). However, a drawback of ARM as a normalizer is that ARM is very sensitive to magnetostatic interaction among magnetic grains. In sediments of the North Pacific, IRM works better than ARM as a normalizer, which is indicated by a smaller coherence between the normalized intensity and the normalizer when IRM is used. In the sediments, the ratio of ARM to SIRM inversely correlates with SIRM, which suggests significant influence of the magnetostatic interaction: a decrease of ARM acquisition efficiency with an increase of magnetic concentration. In this study, I estimate relative strength of magnetostatic interaction among magnetic particles from a spread of FORC distribution in the direction of Hu axis. I evaluate semi-quantitatively the spread by an area of a FORC profile along a line that is parallel to Hu axis and passes through a peak in Hc. In the North Pacific sediments, the relative strength of the interaction measured by the area inversely correlates with ARM/SIRM ratio. On the other hand, there is no evidence of magnetic grain-size variation; profiles along the Hc axis on the FORC diagrams are similar with each other, and hysteresis parameters show a tight cluster in a PSD region on the Day plot. These results indicate that the interaction dominantly controls the ARM/SIRM ratio. The effect of the interaction on DRM acquisition is not understood well, but if it is similar to that on IRM, normalization by ARM may overcompensate magnetic concentration variations and cause a significant coherence between the normalized intensity and the normalizer. Considerable number of papers using sediments of other regions also reported that normalization by IRM shows smaller coherence or correlation between normalized intensity and normalizer than by ARM (e.g. Tauxe and Shackleton, 1994; Lehman et al., 1996; Channell et al., 1998; St-Onge et al., 2003). IRM may be preferable to ARM as a normalizer for a wide range of sediments.

Keywords: paleomagnetism, paleointensity, interaction

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ASI004 **Oral Presentation** **3074**

The multispecimen parallel differential PTRM method for absolute paleointensity determination

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Recently a new protocol for determining absolute paleointensity (PI) in igneous rocks was proposed (Dekkers and Bhnel, 2006, EPSL 284, 509-517) that is independent of magnetic domain state of the NRM (i.e. TRM) carriers. By giving a laboratory pTRM parallel to the original TRM and having the field applied throughout the complete pTRM cycle, one can replicate the original TRM if laboratory field and orginal field are identical. This applies only to the first pTRM treatment, all subsequent treatment is partially dependent on the previous treatment, complicating interpretation. If the laboratory field is weaker than the original field, a weaker composite remanence is the result; if the laboratory field is stronger, a stronger composite remanence is the result. The differences scale linear with pTRM field independent of magnetic domain state, so that by giving a pTRM to a given (and the same) temperature to a set of specimens the paleointensity can be calculated straightfrowardly. Diffusion-after effects and chemical alteration can bias the result. We show the merit of the protocol on artificial samples containing multidomain grains, and historic lavas. Further we document that microwave (perpendicular method) and multispecimen parallel differential pTRM PI results are equivalent for a set of monogenetic lavas of about 200 ka.

Keywords: paleointensity, geomagneticfield, igneousrock

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ASI004 **Oral Presentation** **3075**

Magnetic cooling rate dependency and paleointensity determination

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The acquisition of a thermal remanence is dependent on the cooling rate. Cooling rate experiments on various basaltic samples representing different magnetic domain states confirm that single domain particles acquire a larger TRM after slower cooling. This TRM difference is decreasing with increasing domain state. Therefore, differences between laboratory and natural cooling rates can lead to significant intensity bias, particularly for single domain states.T he possibility of cooling rate correction of paleointensitye stimates was investigated for various Holocene volcanic glass samples, in particular, from a vertical profile across a 600 A.D. obsidian lava flow ramp from Lipari, Italy. The natural cooling rates at the glass transition are determined by relaxation geospeedometry, which involves the measurement of the specific heat capacity of the glass during several heating/cooling cycles using a differential scanning calorimeter. For the seven investigated samples of the Lipari flow ramp these natural cooling rates vary by a factor of more than 4. Rock magnetic investigations indicate a magnetic microlite fraction in the single-domain grain size range and strong magnetic anisotropy. The thermoremanence anisotropy tensor was determined for each specimen to correct the paleointensity results for this anisotropy. The cooling rate dependency of the thermoremanence was determined experimentally. Extrapolation to natural cooling rates indicate an overestimate of the paleointensity by 13% to 20% during experiments with typical laboratory cooling rates. Correcting for the different cooling rates and the cooling rate dependencies within the vertical profile,significantly reduces the standard deviation of the average flow paleointensity.

Keywords: paleointensity, cooling rate, volcanic glass

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ASI004 **Poster presentation** **3076**

How strong was the geomagnetic field during the Cretaceous Normal Superchron?

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The behaviour of the geomagnetic field during the Cretaceous Normal Superchron is a matter of continuing debate. Presently available palaeointensity data is scarce and the results show large scatter. More high quality data is needed in order to resolve whether the field is high, low or variable during this time. Unfortunately it is not a simple task to find suitable samples. Here we present preliminary results from an ongoing project to obtain CNS age palaeointensities using the microwave palaeointensity technique. The advantage of using the microwave method is that alteration during the experiment can be reduced leading to higher experimental success rates. Additionally, consistency between results obtained using different methods provides greater confidence in the results. However, as with the conventional Thellier method, samples must contain an original thermal remanence which is carried by single domain behaving grains. Rock magnetic analyses, SEM imaging and EBSD analyses have been carried out in order to determine mineralogy, domain state of the magnetic carriers and freshness of the samples. Microwave palaeointensity results are presented and compared to previously published Thellier results (where present) for whole rock samples from Inner Mongolia (113 Ma), Liaoning Province, China (102 Ma) and Madagascar (88 Ma).

Keywords: palaeointensity, cns, microwave

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ASI004 **Poster presentation** **3077**

Some unusual magnetic minerals found in palaeo-slags, North Bohemian Browncoal basin; their termomagnetic and low field characteristics

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Marta Chlupacova, Vladimir Zacek, Roman Skala, Frantisek Hrouda

Porcellanites and palaeo-slags from the North Bohemian Brown Coal Basin, Upper Cenozoic, represent very suitable natural materials for palaeomagnetic and palaeointensity studies (Krs 1968, Krs and Vně 1967, Krsov et al. 1989, Tyrček 1994). The advanced mineralogical study of some of these paleo-slags have been newly realized (ček a Skla, under preparation) and magnetic properties of these rocks have been investigated. Pyrometamorphic rocks were formed during palaeo-combustions of coal seams along their exothermal contact, very likely from Upper Pliocene to Holocene. Microprobe and RTG study revealed the presence of minerals of the spinel group, solid solutions having in each sampling point specific mutual ratio of magnezioferrite, magnetite, spinel, etc. component. In buchite from the locality of elenky, there were found barium-hexaferrite and calcium-ferrites (ček et al. 2005). Variations of magnetic susceptibility with temperature in the range from -190 C to 700 C and susceptibility changes of in weak magnetic fields in the range from 2 to 450 A/m of samples from the localities of Dobrčice, Nechvalice, Blina and elenky were measured in the lab of Agico s.r.o. Brno to add magnetic characteristics to the mineralogical description of feromagnetic minerals existing in palaeo-slags. <wrap type="topAndBottom"></wrap>

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ASI004 **Poster presentation** **3078**

Assessment of in-flow palaeointensity variation from samples recording the Brunhes-Matuyama geomagnetic field reversal using first-order reversal curves

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Samples from La Palma that record the Brunhes-Matuyama geomagnetic field reversal have been analysed using the microwave palaeointensity technique at the University of Liverpool. For some flows, a large variation in intensity is seen: one flow gives intensity estimates between 23T and 48 T. First-order reversal curves (measured at the Institute of Rock Magnetism) are used to investigate the magnetic properties of these flows, and to determine whether the magnetic properties of the samples are linked to the intensity variations. Identifying samples and flows that have the most reliable magnetic characteristics should allow palaeointensity to be more accurately determined. This is important if we are to include this data in any global reconstruction of the Brunhes-Matuyama reversal.

Keywords: brunhes matuyama, palaeointensity, forc

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ASI004 **Poster presentation** **3079**

Testing multiple specimen absolute paleointensity determination: Theory and experiments

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Roman Leonhardt

Two recent proposals of multiple specimen measurements appear to have a large potentialto improve and simplify absolute paleointensity determination. Both methods,explicitly or implicitly, are based on a fundamental symmetry claim for thermoremanencein multidomain particles (Biggin and Poidras, EPSL 245, 438-453, 2006). Thisclaim states that, independent of grain size, partial thermal demagnetisation and remagnetisationtreatments are to first order symmetric with respect to small field shifts.Here we present a theoretical analysis of the assumptions behind this claim and derivethe basic conditions for its validity. We further outline how the multiple specimen paleointensitytechnique proposed by Dekkers and Bhnel (EPSL, 248, 508-517, 2006)relies on these symmetry conditions. Our theoretical analysis and experimental testssuggest only a limited validity of the symmetry relations. We point out that an especiallyimportant condition in the multiple specimen technique is, that during heatingthe field is not set back to zero. Otherwise the symmetry relations would be in markedconflict with previous experimental work. In any case, there are some conflicting experimentaldata in the literature, which question a full symmetry of TRM processes.We present new experimental data, which show that the multiple specimen methodtends to overestimate paleointensity for intermediate PSD to MD particle sizes.

Keywords: paleointensity, rock magnetism

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ASI004 **Poster presentation** **3080**

The IZZI paleointensity protocol and its novelty

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Paleointensity determinations based on double-heating techniques are considered to be functionally interchangeable producing equally reliable estimates. However, such premise is valid only for true single-domain (SD) grains. In a recent study, a new paleointensity protocol (so-called the IZZI method) that alternates the Aitken (IZ; in-field and zero-field) technique and the Coe (ZI; zero-field and in-field) method including the partial thermoremanent magnetization (pTRM) checks was suggested. The IZZI method is superior to other double-heating protocols because it can easily detect the angular dependence of pTRM tails and because it does not require pTRM tail checks. The IZZI data display a zigzagging trend, because of the non-equivalency between the IZ and ZI sets. The initial state dependence of pTRM and pTRM tails is responsible for such a zigzagging. In addition to the commonly used quality factors of Coe et al. [1978], a newly defined sample selection criterion (a zigzagging parameter Z*) is necessary to properly diagnose the quality of paleointensity data.

Keywords: paleointensity, izzi, thermoremanence

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ASI004 **Poster presentation** **3081**

Paleointensity of the geomagnetic field derived from neolitic remnants from South-Western Slovakia

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2 Hrouda Frantisek, 3 Hovorka Dusan

The archeomagnetic investigation was performed on the 45 specimens of 10 ceramic potsheds from 4 localities of Western Slovakia and on 31 specimens of 8 ceramic potsheds from 8 localities of Southern Slovakia. Classical Thellier method, or method of double heating, was used (Thellier and Thellier, 1959). Archeomagnetic artefacts were provided by Archeological Institute SAS at Nitra. All magnetic measurements were carried out in Paleomagnetic laboratory of the Geophysical Institute SAS. Different amount of specimens (from different localities) was caused by extension of archeological artefacts. After each thermal steps of Thellier method the magnetization as well as magnetic susceptibility were measured. In archeomagnetism an acquisition of thermoremanent magnetization (TRM) of baked artefacts is generally linked with the presence of magnetic minerals. To reveal an origin of TRM of respective artefacts a study of magnetic minerals is important. The Curie temperature measurement method of crushed samples was used as the most effective way for the qualitative determination of the magnetic minerals. It was performed partly in AGICO Brno and partly in GPI SAS Bratislava. From these measurements it has been evidenced that the carriers of magnetism are Fe-oxides – the association of magnetite and hematite. The samples were heated till to temperature 600–700C but because they desintegrated in the middle temperatures, measurements were performed only till to 450C. This fact gives an idea that ceramic artefacts from which investigated samples are coming were heated not much higher than 400C. This confirms also crossection study of samples where the remnants of unperfect burning plants are visible. Calculated ratios HP/HL are for the case of collection from Western Slovakia in the interval 0.58 – 1.04 and for the case of collection from Southern Slovakia in the interval 0.37 – 0.68 (HP means paleofield and HL laboratory - present geomagnetic field). Comparison of obtained data with archeomagnetic scales (Bucha, 1975; Wagner, 1998) shows that ages of ceramics remnants from Western Slovakia are from 1800 to 5800 years B.C. and from Southern Slovakia from 3750 to 4900 years B.C. If the ages of samples are specified more precisely by archeological methods our results will contributed to evaluation of geomagnetic field intensity in the part. References Thellier, E., Thellier, O., 1959: Sur l'intensit du chmps magntique terrestre dans le pass historique gologique. Ann. Gophys., Paris, 15, 285-276. Bucha, V., 1975: Geomagnetick pole a jeho přnos k objasněn vvoje Země. Academia, Praha, 366. Wagner, G.A., 1998: Age Determination of Young Rocks and Artifacts. Springer-Verlag, Berlin, 364-370.

Keywords: paleointensity, archeomagnetism

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ASI004 **Poster presentation** **3082**

Tertiary volcanic rocks from the Patagonian plateau, Argentina.

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Geophysic IAGA IAGA

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The Patagonian plateau basalts are a sequence of flat-lying Late Cretaceous through Tertiary basaltic and andesitic rocks exposed east of the Andes in dissected mesetas of Chilean and Argentine Patagonia. The plateau basalts cover a total area of 120,000 km2 between 40S and 52 S. These igneous rocks rest on generally flat-lying older Mesozoic silicic volcanic or sedimentary rocks. Of major importance to the paleomagnetic investigation is the lack of significant tectonic disturbance of this portion of Patagonia from Late Cretaceous to present.12 sites (107 cores) have been sampled in the Tertiary (Paleocene to Miocene) volcanic rocks between 43S and 46S in latitude and between 68W and 70W in longitude. Rocks are usually very fresh but, as they outcrop generally on top of the mesas, few hundred meters above the Plateau, remagnetization by lightning strikes is a major problem of the paleomagnetic analysis.Paleomagnetic, rock magnetic and paleointensity results will be presented.

Keywords: paleointensity, tertiary, patagonia

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ASI005 **3083 - 3103**

Symposium
Magnetic anisotropy different scales, different parameters, different stories?

Convener : Dr. Fatima Martin Hernandez

In the past 50 years the anisotropy of magnetic susceptibility (AMS) has established itself as a rapid and sensitive petrofabric tool that can be used, among other things, to infer flow/emplacement directions in sedimentary and igneous rocks, principal orientations of incremental strains, or to study complex fabric superpositions in many types of rocks. In recent years, AMS studies have expanded their scope either by developments in the theory linking the acquisition of mineral fabrics, by the increase in the sophistication of already existing measurement techniques or by the inclusion of a new family of measurements that include anisotropies of remanence and of high fields. This session aims to bring together recent studies of magnetic anisotropy made from all different scale perspectives, from mineral fabrics to bulk anisotropy, with special emphasis in investigations made with new types of measurements (AARM, AIRM, HF-AMS, etc.) or temperatures. Correlations between magnetic fabric and mineral fabrics with texture goniometry, neutron diffraction, image analysis or BSED are also of interest, and specially those methods that can be used to separate the contributions from mineral subfabrics present in a single rock

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ASI005 **Oral Presentation** **3083**

Guidelines for interpretation of anisotropy of magnetic susceptibility in lava flows. Example from a Tiretaine lava flow (Chane des Puys, France).

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Anisotropy of Magnetic Susceptibility (AMS) is a convenient method for finding strain and thus emplacement information on lava flows. However, interpretation of AMS parameters, such as degree of anisotropy, requires caution and several factors need verification to avoid misunderstandings. Verification can be divided into 2 groups: 1) what minerals create AMS? 2) how AMS behaves? 1) For the magnetic minerals, thin sections are needed for estimating concentrations, sizes, shapes and compositions. Then Curie temperature determination will indicate if magnetites are the main AMS carrier. First Order Reversal Curves (FORCs) are then performed to find the magnetic type: multi domain (MD) or single domain (SD). 2) To find AMS behaviour, a comparison between AMS ellipsoid and microlite fabric ellipsoid shows how AMS is acquired and if it is controlled by the silicate template. An example was taken on a 4.5m-high vertical profile from a lava flow of the Tiretaine valley (Chane des Puys, France) where it becomes narrower. Results show that AMS is carried by interstitial titanomagnetite, with a 5 to 50 m size. The FORCs show that AMS is mainly due to MD magnetites. The absence of SD magnetites will not create a cross-flow fabric (kmax perpendicular to the downflow direction). The comparison between the magnetic and microlite fabric shows that AMS fabric is controlled by the silicate template. Magnetites are therefore late formed, i.e. during the late stages of emplacement/deformation, when significant cooling had occurred. Moreover kmax is parallel to the downflow direction and thus kmax is significant in term of maximal elongation axis $\lambda 1$. The degree of anisotropy profiles can not be used as a tool for estimating lava flow deformation as titanomagnetites cover a large size and shape range, and so the magnetic fabric is assumed to be stabilized. However, degree of anisotropy is not constant and displays several breaks linked with changes in the kmax dip. This indicates several horizontal interfaces. Compartments between interfaces can display kmax dip greater than 45, that is to say greater than the incremental elongation axis during simple shear deformation. As a consequence pure shear may be contributing all the more since the valley is narrower. As the pure shear is assumed to be constant in the lava profile, variations of simple shear intensity will allow kmax dip greater than 45. The lava flow section should thus be considered to be undergoing general pure shear, but compartmentalised into different simple shear bands. A way to explain such differences of the simple shear amount is the existence in the lava flow of layers with different viscosities. A more viscous lava will undergo less simple shear than a more fluid one. To check this hypothesis, analogue modelling is in progress. The guidelines given here for interpretation of kmax dip and degree of magnetic anisotropy can be used in any lava flows, but also on intrusions. In the studied case, the magnetic parameters have showed the fact that a lava flow can display vertically differences in simple shear and a way to explain such variations is the consideration of more viscous compartments in the lava flow.

Keywords: ams, kmax dip, simple shear

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ASI005 **Oral Presentation** **3084**

Can the preferred orientation of paramagnetic carriers in cleaved siliciclastic metapelites be determined by means of X-Ray pole figure goniometry?

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The anisotropy of magnetic susceptibility (AMS) is a commonly used petrofabric tool that is applied in many geological environments for quite a number of purposes (determination of palaeocurrent, magma flow, tectonic transport,). However, within any given rock, AMS is controlled by all magnetic carriers present (s.l.; diamagnetic, paramagnetic and/or ferromagnetic carriers), which, depending on the geological history, may have different orientations. Consequently, generally AMS cannot be interpreted in terms of geological processes, unless all the magnetic (s.l.) carriers and the different magnetic orientation populations are successfully identified. Within cleaved, low-grade, siliciclastic metapelites, the main paramagnetic carriers are phyllosilicates, which, together with quartz (diamagnetic carrier), constitute the bulk of the rock. Hence, in cleaved metapelites, in which paramagnetic carriers control AMS, one often uses Xray pole figure goniometry (X-PFG) to determine the preferred orientation of the main paramagnetic carriers. Possible mismatches between X-PFG- and AMS-results can then often be attributed to traces of ferromagnetic carriers. The cleaved, Lower Palaeozoic metapelites of the Anglo-Brabant Deformation Belt (Belgium) commonly show composite AMS fabrics. In order to separate the different subfabrics of AMS, we applied X-PFG and also determined the preferred orientation of the ferromagnetic carriers using the anisotropy of the anhysteretic remanent magnetisation (AARM). The results of this combined method, however, are not always satisfactory, as often clear mismatches are observed between the results of AMS, X-PFG and AARM, that cannot readily be explained. In particular, this is the case for samples in which, judging from the bulk susceptibility and the degree of anisotropy, there appears to be no ferromagnetic contribution. Whereas in these problematic samples the preferred orientation of chlorite and white mica (X-PFG) is always subparallel to cleavage and also AARM is generally parallel to cleavage, the AMS-foliation is not always parallel to cleavage. Possibly, this is due to the presence of a bedding-parallel paramagnetic carrier that partly controls AMS, but that is not detected by X-PFG. In order to check this hypothesis, AMS was performed at ~77K (liquid nitrogen), which enhances the paramagnetic signal. In addition, for a few samples also a torque magnetometer was used. These results show that, although X-PFG shows a cleavage-parallel (paramagnetic?) phyllosilicate fabric, the paramagnetic AMS (low-T-AMS) is clearly subparallel to bedding, thus supporting our hypothesis. In addition, an examination of the low-T-AMS suggests that also the paramagnetic AMS is a composite fabric. Hence, also this fabric should be resolved into its different subfabrics prior to geological interpretation. The results imply that, even in metapelites in which the phyllosilicates are considered to represent the main paramagnetic carriers, X-PFG will not necessarily provide the paramagnetic carrier orientation. Any attempt to link AMS to strain in metapelites, hereby using X-PFG, is therefore quite questionable.

Keywords: x ray pole figure goniometry, ams, aarm

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ASI005 **Oral Presentation** **3085**

Diamagnetic fabrics

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The contribution of diamagnetic anisotropy to the total anisotropy of magnetic susceptibility (AMS) in a rock is often very small and easily overprinted by the anisotropy from paramagnetic and ferromagnetic phases. Although the anisotropy of diamagnetic minerals may be relatively strong, as in the case for calcite, very few studies have isolated these fabrics. Initially we have undertaken a systematic study of carbonate minerals to establish their magnetic anisotropy in relationship to the amount of iron, which is often incorporated into the crystal structure and causes the susceptibility to become paramagnetic. In a further step, a method was developed to separate the diamagnetic fabric from the total AMS, by measuring the susceptibility anisotropy in high fields at room temperature and 77 K with a torque magnetometer. This procedure exploits the fact that the ferrimagnetic contribution to the torque signal undergoes saturation in high fields, the paramagnetic susceptibility increases at low temperature, and the torque of the diamagnetic contribution shows no temperature dependence. The method was tested on a series of synthetic marbles fabricated from calcite and muscovite powders. Results showed that it is possible to isolate the diamagnetic fabric for samples if its contribution was more than 5% of the total anisotropy. Additional tests were made on deformed limestones from the Morcles Nappe, where it was possible to isolate subfabrics due to Fe-poor and Fe-rich calcite within a single locality. Theoretical and practical limitations of using this procedure to isolate the diamagnetic contribution to the magnetic fabric will be discussed.

Keywords: magnetic anisotropy, diamagnetism, calcite

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ASI005 **Oral Presentation** **3086**

Paleomagnetism and Rock Magnetism study of the Shepody Fm. of New Brunswick and Nova Scotia, Canada, for an anisotropy based inclination shallowing correction.

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A series of anisotropy measures have been performed on the hematite- rich Lower Carboniferous Shepody Formation red beds of New Brunswick and Nova Scotia in conjunction with standard paleomagnetic measurements in order to apply an anisotropy- based inclination correction. Paleomagnetic measurements revealed the presence of a primary component carried by hematite and a secondary, syn-folding component, carried by maghemite. Anisotropy of magnetic susceptibility (AMS) was used in conjunction with chemical demagnetization to calculate a reduced anisotropy ellipse for the characteristic remanence- carrying grains. The resulting fabric is strongly bedding parallel with bedding perpendicular minimum axes. It has been interpreted as a primary depositional/ compactional fabric and was successfully used for an inclination shallowing correction. The magnetic mineralogy of the Shepody Fm., as revealed by demagnetization intensity curves, isothermal remanence magnetization (IRM) acquisition experiments and Lowrie tests, is complex and composed of maghemite, hematite and goethite. In order to develop a more time- efficient technique that isolates the contribution of hematite to the fabric, a new protocol was devised. It consists of measuring the anisotropy by imparting IRMs in high fields (5 T) to activate the hematite, and following each magnetization step with a thermal demagnetization step at 120 and an alternating field demagnetization (AF) step at 100 mT to eliminate the contributions of goethite and maghemite, respectively. The fabric obtained through this procedure is very comparable to the AMS fabric and yielded a very similar inclination correction. The orientation of the principal axes, however, shows a slight imbrication indicating deposition from a paleocurrent. A magnetic fabric was also measured for the secondary component. Because maghemite is the carrier and is a lower coercivity phase, the fabric was measured using anisotropy of anhysteretic remanence (AAR). Since the remanence was acquired at 70% unfolding the fabric was analyzed both in stratigraphic and 70% unfolded coordinates. In stratigraphic coordinates the fabric is discernible and mimics the primary fabric determined through high field (hf) IRM, however it is poorly defined in 70% unfolded coordinates. Thus, this fabric may be an example of a primary-appearing, inherited fabric, that is carried by secondary magnetic minerals.

Keywords: ams, irm, aar

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ASI005 **Oral Presentation** **3087**

A new technique for determination of initial susceptibility tensor through measurement of the AMS in the Rayleigh Law region

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Theory of the anisotropy of magnetic susceptibility (AMS) is based on the assumption of linear relationship between magnetization and magnetizing field, resulting in field-independent susceptibility. As the instruments measuring the AMS use relatively weak fields, they have been long time considered to measure the field-independent susceptibility. However, recent investigations have shown that this assumption is really valid for paramagnetic minerals and magnetite, while pyrrhotite, hematite and titanomagnetite may show clear variation of susceptibility in the same fields. Consequently, the use of the linear theory is in principle incorrect in the last cases. However, recent investigations have shown that using linear theory does not necessarily give rise to inaccurate results in all AMS aspects. Namely, the variations of the principal directions and of the AMS ellipsoid shape with field are weak, negligible with respect to common measuring errors. Consequently, if one is primarily interested in the orientations of magnetic lineation and foliation and in the symmetry of the AMS ellipsoid, and this is the case of most geological applications, one can use the simple and illustrative linear theory without danger of the loss of accuracy. On the other hand, the degree of AMS may show conspicuous variation with field and, if one wants to make precise quantitative fabric interpretation, it is desirable to work with the AMS of the initial susceptibility that is field-independent. The new technique of determining the initial susceptibility tensor is based on the assumption that each component of the susceptibility tensor measured in variable fields shows linear relationship with field within the Rayleigh Law range. The intercept of this straight line then represents the value of the component of the initial susceptibility tensor. The validity of the above assumption is evidenced empirically through mathematical modelling of the measuring process. This technique is advantageous mainly in using the method of spinning specimen that is able to measure the AMS very fast (one measurement takes about 2 minutes only). Examples of the use of this technique are shown.

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ASI005 **Oral Presentation** **3088**

Meandering flow of a pyroclastic density current documented by the Anisotropy of Magnetic Susceptibility (AMS) of the ignimbrites of the Cimini dome complex (Central Italy)

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Anisotropy of Magnetic Susceptibility (AMS) reflects the shape and spatial arrangement of minerals within a rock, and has been used in many studies to evaluate flow directions in pyroclastic deposits, in order to determine vent location or, more recently, to provide information about transport and depositional processes involved at different distances from the vent. In this study we investigate the behaviour of the pyroclastic density currents that deposited the ignimbrites associated with the Cimini lava dome complex (Central Italy), examining in detail how the flow and depositional mechanisms change from the base to the top of an ignimbrite. Low field AMS has been integrated with high field AMS measurements, to show that paramagnetic and ferromagnetic fractions both contribute to the AMS of the ignimbrites. The combination of high field and low field AMS gives greater insight into the orientation and behaviour of grains with different shapes. The results of AMS analyses suggest that the pyroclastic density currents changed both direction and character during deposition of the ignimbrites. The meandering behaviour of the currents can be observed on the scale of 15-cm increments in the deposits in an area lacking significant palaeotopography. AMS data from 1, 2, and 4 metre increments through the ignimbrites also show complex changes in flow direction throughout their deposition. The progressive shifts in the AMS fabric give important implications about the deposition of the ignimbrites. Firstly, varying alignments of the AMS fabric in the two vertical sections seem to require that they were not deposited en masse. These results clearly document that the ignimbrites were deposited incrementally or progressively. Secondly, these variations in direction also support the concept that pyroclastic density currents may meander, or change direction as deposition progresses. The phenomena observed in this study have broad implications for the general methodology of AMS studies. Detailed vertical profiles made up of several individual sample sites can reveal current flow variations that may give misleading information if sampled sparsely.

Keywords: ams, ignimbrite, cimini

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ASI005 **Oral Presentation** **3089**

Sampling strategies and the anisotropy of magnetic susceptibility of dykes.

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Most studies of the anisotropy of magnetic susceptibility (AMS) of dykes have assumed that susceptibility axes should define a unique orientation relative to the dyke walls and magma flow direction. Theoretical considerations, however, predict systematic variations of AMS as a function of the amount of shear experienced by the flowing magma. Although this feature of AMS might seem undesirable at first sight, based in a theoretical model it has been suggested that actually we can take advantage of such variation in the orientation of the AMS axes to infer magma flow directions more confidently than until now if proper attention is given to the scheme followed during sample collection. In this work we report the results of a pilot study made to test those theoretical predictions. We resampled two dykes from the Koolau dyke complex in Oahu and for which magma flow direction was previously inferred albeit with some uncertainty. The resampling was made following the guidelines suggested by the theoretical work as closely as possible (i.e., collecting more than one profile parallel to the dyke walls and across the dyke). The results of our measurements are in good agreement with the theoretical model and allow us to identify specimens with a "wrong" orientation in a given profile. Therefore, we show that despite a complex relation between magma kinematics and magnetic fabric, the measurement of AMS can yield enough information to assess many aspects related with the mechanism of emplacement of many igneous rocks.

Keywords: dykes, magnetic fabric, magma flow direction

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ASI005 **Oral Presentation** **3090**

The importance of the AMS analysis for reconstructing the tectonic history in weakly deformed sediments

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The anisotropy of magnetic susceptibility (AMS) has been recognized as a highly sensitive indicator of rock fabric and widely employed in the field of structural geology. Magnetic fabric measurements quantify the bulk-preferred orientation of all magnetic minerals that are present in a rock sample. However, in order to interpret AMS in terms of strain, the nature and preferred orientation of the magnetic carriers likely influencing the magnetic fabric have to be determined. Several methods have been developed in order to separate paramagnetic and ferrimagnetic sub-fabrics, such as exploiting the field or temperature dependence of magnetic susceptibility or the measurement of anisotropy of anhysteretic remanence. One of the not yet fully understood topics is the origin of the magnetic lineation under progressive deformation. Based mainly on magnetic studies in deformed rocks from compressional tectonic settings, several different mechanisms have been invoked, such as grain rotation, pressure solution or neocrystallization. The combination of rock magnetic measurements (e.g. low temperature and high magnetic field measurements) with nonmagnetic analysis (e.g., neutron texture analysis) demonstrates that magnetic minerals distribution has an important control on magnetic anisotropy. Less is known about the origin of magnetic lineation in claystones, because of the common scarcity of strain markers (faults, folds, cleavage) and their fine-grained nature, which make difficult, or even impossible, to perform strain analysis. In this talk, the development of magnetic fabric during deformation is discussed, together with the hypotheses proposed to explain the origin of magnetic lineation in deformed rocks. Particular attention is focused on weakly deformed rocks, where no evidence of tectonic deformation is visible at the outcrop scale, hampering a direct correlation between tectonic and magnetic fabric. The importance of the integration of magnetic and mineral fabric analysis in structural studies is pointed out, underlining that the observed magnetic fabric reflects the magnetic minerals preferred orientation induced by tectonic deformation. In weakly deformed rocks, this approach may represent the unique tool for detecting deformation. In fact, the integration of magnetic and mineral fabric analysis demonstrates to be a suitable tool to study strain mechanism on the grain scale and regional deformation pattern in claystones, even if macroscopic evidence is not visible at the mesoscale.

Keywords: magnetic anisotropy, mineral fabric, neutron diffraction

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ASI005 **Oral Presentation** **3091**

Magnetic anisotropy and rock magnetic characterization of pyrrhotite and hematite single crystals: magnetic structure within the basal plane

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Here we report on the source of magnetic anisotropy in pyrrhotite and hematite. Pyrrhotite is an iron sulfide present in many natural rocks and sediments hematite is an iron oxide; both are important carriers of NRM. Despite their different composition, the crystallographic structure is similar, with a very well defined basal plane to which the magnetization is confined. The relative anisotropy, that is the ratio between the susceptibility within the basal plane and the c-axis is well known, the intrinsic anisotropy within the basal plane shows a broad range of results. A collection of pyrrhotite and hematite single crystals have been measured by low and high-field methods using a KLY4 and a torque magnetometer respectively. The low-field bulk susceptibility and its anisotropy have been determined at different fields. The variation of the bulk susceptibility with the applied field has been fitted empirically into a logarithmic function for pyrrhotite crystals, which shows a smooth grain size dependence. This empirical function is not valid for hematite; here the relationship between low-field bulk susceptibility and applied field is not a simple function. This procedure is proposed to be used as a grain-size estimation technique in samples with only one population of pyrrhotite. The principal directions of the AMS ellipsoid appear to be stable, i.e., independent of the applied field for both minerals. However specific measurements within the basal plane did not show any feature of the structure of this plane. The high-field data magnetic anisotropy within the basal plane in both minerals is expected to be a pure 6theta-term. Most single crystals showed this behaviour whereas in others lower harmonic terms overlapped the 6theta-term. We argue that this may be the dominant source of the observed variation in magnetic properties. However, the presence of several harmonics reveals a more complex structure than the ideal structure, particularly in the case of hematite. The torque for pyrrhotite curve has been fitted into the theoretical function to estimate the anisotropy constant within the basal plane (K1). This is possible because the available fields are able to saturate the magnetization of pyrrhotite and not to hematite. The values obtained in the present work together with a re-evaluation of reported data yields a new value of K1=(2.83 0.10) 104 Jm-3. This value is essential for any accurate anisotropy model in pyrrhotite-bearing rocks.

Keywords: magneticanisotropy, hematite, pyrrhotite

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ASI005 **Oral Presentation** **3092**

Magnetic fabrics in saucer-shaped sills of the Karoo Large Igneous Province

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Magmatic sill intrusions exhibit the fundamental saucer geometry in undeformed sedimentary basins and volcanic rifted margins. Current emplacement models are based on the analysis of the intrusion geometry and their spatial relationships with potential feeders, not on the knowledge of the magma flow geometry. The Karoo Basin of South Africa hosts the best exposed complexes of saucer-shaped sills. The Golden Valley Sill is exceptionally well-exposed and displays the connections with adjacent and nested saucers. The aim of this study is to determine the magma flow geometry within the Golden Valley Sill Complex. Detailed fieldwork observations and anisotropy of magnetic susceptibility method were used to identify strain markers that can be interpreted in terms of magma flow directions. A total of 113 localities (6 specimens/site) have been sampled for anisotropy of magnetic susceptibility (AMS) analysis. The magnetic properties were defined by measuring hysteresis cycles and K-T curves on 34 and 19 specimens, respectively. The presence of pseudo-single domain magnetite grains allows the correlation of the magnetic fabric with the petrofabric. The bulk susceptibility varies slightly with a value averaging 13.5 10-3. Only 4 localities display an imbrication of the magnetic foliation that can be interpreted in terms of magma flow directions. The remaining localities display a magnetic well defined foliations that consistently dip outward the Golden Valley Sill. The orientation of the magnetic foliation is interpreted as reflecting post-emplacement deformations. In conclusion, AMS data and the observed magma flow geometries, derived from macroscopic flow indicators, correlate well and are used to constrain an emplacement model for the Golden Valley Sill Complex. This study further demonstrates that the Golden Valley could be regarded as a reference site for saucer-shaped sill complexes.

Keywords: ams, magma flow, saucer shaped sills

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ASI005 **Poster presentation** **3093**

Effect of plastic deformation in laboratory conditions on AMS of sedimentary rocks

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In order to correlate the degree of plastic deformation and low-field magnetic anisotropy a series of laboratory pressure experiments was carried out on a batch of grey marls. Standard one inch cylindrical samples were gradually deformed using triaxial high-pressure device. The confining pressure of 300 MPa was used, yielding maximum relative deformation up to 20 % depending upon the uniaxial differential stress (maximum 550 MPa). Majority of the samples in concern exhibited no macroscopic break-down. AMS as function of degree of plastic deformation was measured using Kappabridge KLY-3. Our results demonstrate that laboratory deformed samples are characterized by increasing degree of magnetic anisotropy and, to certain extent, by increasing foliation. Changes in AMS are analysed in relation to both the initial degree of magnetic anisotropy and orientation of the AMS ellipsoid. Since no significant contribution of ferrimagnetic minerals to the total AMS was confirmed, reorientation of paramagnetic phyllosilicate grains due to plastic deformation seems to be the most probable mechanism of AMS changes.

Keywords: ams, plastic deformation, sedimentary rocks

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ASI005 **Poster presentation** **3094**

Seismic and Elastic Properties in Relation to the Anisotropy of Magnetic Susceptibility of Synthetic Calcite-muscovite Aggregates

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Synthetic marbles with varying amounts of calcite and muscovite have been examined using a combination of seismic velocities and anisotropy of magnetic susceptibility (AMS). The samples were prepared through cold-pressing, using uniaxially applied stresses which range from hand-pressing to 400MPa, and subsequent annealing. The textural fabric, determined with neutron diffraction, is transversely isotropic; c-axes of calcite and muscovite cluster parallel to the axis of compression. Due to the orientation of the cylinders during preparation, all seismic measurements were confined to cores extracted parallel of the axis of applied stress. Compressional (P) and shear (S) waves display decreasing velocities with increasing muscovite content. Poissons ratio decreases with higher muscovite content; low values for pure muscovite samples are related to their crystallographic preferred orientation. The magnetic fabric is well defined in the synthetic marbles, with the minimum direction of susceptibility parallel to the axis of compression, whereas maximum and intermediate directions are confined in a great circle nearly perpendicular to the axis of compression. As muscovite concentrations exceed ~5% by volume, the bulk magnetic susceptibility switches from diamagnetic to paramagnetic. The eccentricity of the separated paramagnetic AMS ellipsoid shows an inverse relationship with measured seismic velocities; as the paramagnetic susceptibility ellipsoid becomes increasingly flattened, the seismic velocities are reduced. The separated diamagnetic fabric (for muscovite volume content ≤30%) show no relationship with the seismic velocities.

Keywords: anisotropy, texture, calcite muscovite

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ASI005 **Poster presentation** **3095**

Effects of magnetic interactions in anisotropy of magnetic susceptibility: models, experiments and implications for igneous rock fabrics quantification

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Besides granites of the ilmenite series, in which the anisotropy of magnetic susceptibility (AMS) is mainly controlled by paramagnetic minerals, the AMS of igneous rocks is commonly interpreted as the result of the shape-preferred orientation of unequant ferromagnetic grains. In a few instances, the anisotropy due to the distribution of ferromagnetic grains, irrespective of their shape, has also been proposed as an important AMS source. Former analytical models that consider infinite geometry of identical and uniformly magnetized and coaxial particles confirm that shape fabric may be overcome by dipolar contributions if neighboring grains are close enough to each other to magnetically interact. On these bases we present and experimentally validate a two-grain macroscopic numerical model in which each grain carries its own magnetic anisotropy, volume, orientation and location in space. Compared with analytical predictions and available experiments, our results allow to list and quantify the factors that affect the effects of magnetic interactions. In particular, we discuss the effects of (i) the infinite geometry used in the analytical models, (ii) the intrinsic shape anisotropy of the grains, (iii) the relative orientation in space of the grains, and (iv) the spatial distribution of grains with a particular focus on the inter-grain distance distribution. Using documented case studies, these findings are summarized and discussed in the framework of the generalized total AMS tensor recently introduced. The most important result of our work is that analytical models far overestimate the role of magnetic interaction in rock fabric quantification. Considering natural rocks as an assemblage of interacting and non-interacting grains, and that the effects of interaction are reduced by (i) the finite geometry of the interacting clusters, (ii) the relative orientation between interacting grains, (iii) their heterogeneity in orientation, shape and bulk susceptibility, and (iv) their inter-distance distribution, we reconcile analytical models and experiments with real case studies that minimize the role of magnetic interaction onto the measured AMS. Limitations of our results are discussed and guidelines are provided for the use of AMS in geological interpretation of igneous rock fabrics where magnetic interactions are likely to occur.

Keywords: magnetic interactions, igneous rocks

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ASI005 **Poster presentation** **3096**

Asymmetric fabrics in dikes: natural examples from rift zones of Tenerife (Canary Islands)

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Simple shear caused by flow of magma along the static wall rock causes imbrication of the elongated particles against the margins of the dike. If the magnetic susceptibility is controlled by ferromagnetic minerals, the imbrication of the maximum susceptibility axis (K1) with respect to the dike walls will yield the direction and sense of magma flow within the dike. Imbrication on both dike margins commonly results in a symmetric distribution of the K1 axis with respect to the dike plane. However, many dikes show asymmetric (scissored) distributions of the K1 axis, which have been interpreted as the result of tectonic stresses applied during the magma intrusion. Magnetic fabrics determined by AMS have been widely used to deduce magma flow direction in dikes. In contrast, asymmetric AMS fabrics have received little attention in literature and they are normally avoided in order to infer magma flow direction. This contribution presents natural examples of dikes showing an asymmetric magnetic fabric distribution and field evidence of ambient stress resolved on the dike plane (en echelon segmentation, dike offsetting, and dike curvature). We develop conceptual models that allow predicting the rotation of the maximum susceptibility axis K1 of AMS fabrics for three different geometric relationships between shear stress resolved on the dike wall and magma flow: shear stress parallel to magma flow; shear stress perpendicular to magma flow and shear stress oblique to magma flow. The natural examples that illustrate these theoretical models were obtained from vertical basaltic dikes from rift zones of the Upper Miocene basaltic shield of Tenerife (Canary Islands). However, the results obtained are not restricted to this geological setting as similar results could arise from any dike intruded under significant amount of shear stress. Collecting structural data on the dike propagation direction and knowing the sense of shear resolved on the dike plane allow asymmetric magnetic fabrics to be used to infer magma flow direction and sense. Additionally, the minimum angular shear stress resolved on the dike plane during magma emplacement can be estimated by restoring K1 back to its unsheared position.

Keywords: ams, shear stress, dikes

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ASI005 **Poster presentation** **3097**

Separation of pyrrhotite magnetic fabric from magnetite/paramagnetic fabric in granulites of the locality of Bory (Moldanubian Zone of Western Moravia) using the AMS measured in variable low fields

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In a quarry near the village of Bory (Moldanubian Zone of Western Moravia), large ultrabasic body occurs surrounded by granulites. The AMS is used to investigate structural relationship between the ultrabasic body and the surrounding granulites. Unfortunately, the AMS in granulite is carried not only by paramagnetic minerals and magnetite that are likely co-genetic with the rock, but also by pyrrhotite whose origin cannot be excluded to be epigenetic. As the susceptibility of paramagnetic minerals and magnetite is field-independent in weak fields used in the most AMS meters, while that of pyrrhotite is strongly field-dependent, the AMS measured in variable fields can be used to separate the pyrrhotite magnetic fabric from the magnetite/paramagnetic fabric. A new method is developed for this separation.The new technique of determining the pyrrhotite magnetic fabric is based on the assumption that each component of the susceptibility tensor measured in variable fields shows linear relationship with field within the Rayleigh Law range. The slope of this straight line then characterizes the component of the susceptibility tensor due to multi-domain pyrrhotite. The validity of the above assumption is evidenced empirically through mathematical modelling of the measuring process. This technique is advantageous mainly in using the method of spinning specimen that is able to measure the AMS very fast (one measurement takes about 2 minutes only). In the granulites under study, the multi-domain pyrrhotite magnetic fabric is approximately coaxial with the magnetite/paramagnetic fabric. Consequently, the pyrrhotite is not epigenetic, it is at least as old as the main metamorphic schistosity in these rocks. The AMS can then be reliably used to investigate the structural relationship between the ultrabasic body and the surrounding granulites.

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ASI005 **Poster presentation** **3098**

Normal and inverse magnetic fabric in dikes and sills (Eger Graben, NW Czech Republic)

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Recent studies of igneous rocks indicate that the predominant occurrence of normal/inverse fabric in dikes may either reflect the presence of multi-domain (MD) / single-domain (SD) grains or it may result from different orientation mechanisms of magnetic minerals in magmas of different viscosities. The ambiguity in physical vs. geological cause of normal/inverse magnetic fabric must be answered before any successful geological interpretation of magnetic fabric can be made. In order to address this problem, we studied magnetic fabric of selected dikes and sills associated with the SW-NE trending Eger Graben (NW Czech Republic). The studied area offered very extensive collection of rock type: basalt, bostonite, camptonite, phonolite, tephrite, trachybasalt.Magnetic susceptibility varies according to rock type and reflects the relative contents of magnetic minerals. In most cases titanomagnetite with variable Ti-content was identified as main magnetic carrier. The degree of anisotropy is relatively low, in most cases less that 10%. The differences in degree of anisotropy may reflect the differences in viscosities of the respective magmas. Consequently, different mechanisms orienting magnetic minerals should be expected in various rock types. The shape of anisotropy ellipsoid ranges from slightly prolate to neutral and oblate.Several different types of magnetic fabric (using anisotropy of low-field magnetic susceptibility, AMS) were observed in studied dikes: so-called normal and inverse magnetic fabrics and anomalous magnetic fabric. Comparing all studied sites it seems that the type of magnetic fabric is lithology-dependent. Normal magnetic fabric with magnetic foliations and subhorizontal magnetic lineations both parallel to the dike margins was found in bostonite and trachybasalt dikes. Inverse magnetic fabric with magnetic lineations and magnetic foliations perpendicular to the dike margins was found in camptonite dikes. Anisotropy of anhysteretic remanent magnetization (AARM) indicate that the observed inverse magnetic fabric may be caused by the presence of SD magnetic grain; AARM fabric being normal with the respect to dike margins. In contrast to that no single domain particles were revealed using hysteresis loops. Measurements of AMS in variable weak magnetic fields are suggested to decipher this ambiguity.

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ASI005 **Poster presentation** **3099**

Thermal enhancement of AMS and ARM magnetic fabric for granitoids and volcanites (Sudetes, SW Poland) - an attempt to separate suspected composite magnetic fabric.

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The AMS and ARM magnetic fabrics were determined for some batches of samples from granitoids veins (Jawornik unit) from Western Sudetes (SW Poland) as well as from surrounding schists and gneisses of the Złoty Stok - Skrzynka shear zone. For Jawornik granitoids the composite AMS fabric was discovered at the locality scale for several sites suggesting secondary tectonic lineations imposed on an earlier magmatic flow fabric. A such conclusion was supported by microtectonic observations. Steep AMS foliations parallel with major shear zones and generally subhorizontal lineations suggest the origin of Jawornik granitoids in a strike-slip tectonic regime. The heating of samples results generally in some enhancement of the AMS magnetic fabric due to growth of secondary magnetite. We attempt to correlate pre- and postheating AMS and AARM fabric to solve the locality scale deformation mechanisms. Similar procedure is applied for hematite bearing Permian volcanites from North Sudetic Basin for five batches of Permian volcanic rocks of different genesis (tuffs, ignimbrites, lavas). Most lavas and ignimbrites are characterized by subhorizontal magnetic lineation parallel to macroscopically observed direction of flows. However the presence of well-defined mostly steep AMS magnetic foliation remains an open question. Probably, it could be connected with paleo-valley system, which might have been followed by lava and pyroclastic flows. On the other hand, the second scenario, perhaps more realistic, could be suggested. The magnetic foliation might reflect the primary magnetic characteristics of the ascending magma within the conduit system. The heating does not enhance AMS fabric but for some sites new low- temperature ferromagnetic phase (180C) is grown resulting in different ARM fabric. We will discuss the relations between pre- and post-heating ARM fabric whether they are indicative of the mechanism of the generation of the magnetic fabric.

Keywords: composite magnetic fabric, thermal enhancement

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ASI005 **Poster presentation** **3100**

Magnetic Fabrics, Rock Magnetism, Cathodo-luminescence and Petrography of apparently undeformed Bambui Carbonates from So Francisco basin (Minas Gerais State SE-Brazil): An Integrated Study

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Magnetic measurements were performed on apparently undeformed limestones and carbonate shales from 44 sites in nearly-horizontal stratigraphic layers mainly from the basal units of the Neoproterozoic Bambui Group in the southern part of the So Francisco basin. Rock magnetism, cathodo-luminescence, transmitted and reflected light microscopy analyses reveal that there is a mix of ferromagnetic minerals, mainly magnetite and pyrrhotite, in most sites. In some sites, however, the ferromagnetic minerals are magnetite and hematite. Fine-grained pyrrhotite and pyrite accompany rare fine-grained graphite and probably amorphous carbon in some of stylolites, while pyrrhotite is also present as larger interstitial masses in coarse-grained domains outside, but close to the stylolites. Magnetic fabrics were determined applying both anisotropy of low-field magnetic susceptibility (AMS) and anisotropy of anhysteretic remanence magnetization (AARM). The analysis at the individual-site scale defines three AMS fabric types. The first type (2 sites) shows Kmin perpendicular to the bedding plane while Kmax and Kint are scattered within bedding plane itself. This fabric is usually interpreted as primary (sedimentary-compactional), typical of totally undeformed sediments. The second type shows the three well clustered AMS axes with Kmin still perpendicular to the bedding plane. This fabric is the most important since it was found in the majority of the sites. The third type (2 sites) is characterized by well-clustered Kmax in the bedding plane, while Kmin and Kint are distributed along a girdle. The second and third fabric types are interpreted as combinations of sedimentary-compactional and tectonic contributions at the earliest, and at a slightly later stage of deformation, respectively. AMS represents the contribution of all the rock-forming minerals while AARM isolates the contribution of remanence-bearing minerals from the matrix minerals. However, rock magnetism shown that anhystereic remanence only reaches grains with coercivity <100 mT because the maximum AF in the majority of the available instruments is 100 mT.Therefore hematite and pyrrhotite probably do not contribute to AARM which is due to the shape-preferred orientation of magnetite grains. For some sites the AMS and AARM fabric orientations are different, mainly with respect to the lineation (Kmax and Amax, respectively). In general, Kmax is well developed and follows the trend of the main regional thrusts, fold axes and faults generated in the first deformational phase, while Amax follows both this trend and that of structural lineaments formed during the second deformational phase. These deformation phases arose from the compression which occurred during the evolution of the Brasilia fold belt during the last stages of the Brasiliano event. The magnetic fabrics of the Bambui limestones are typical of very weakly deformed sediments, in which the depositional-compaction fabric has been partly overprinted by a tectonic one, with minimum susceptibility direction remaining perpendicular to bedding. This result is in agreement with the textures given by the petrographic observations.

Keywords: magnetic fabrics, rock magnetism, carbonates

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ASI005 **Poster presentation** **3101**

Contrastive strain record within the magmatic fabrics of the lands end granite (SW England): a comparative study of the AMS and feldspar preferred orientation

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The Lower Permian Lands End granite, the westernmost pluton of the Cornubian batholith (SW England), reveals complex magmatic flow pattern defined by aligned alkali-feldspar phenocrysts. This work is essentially focused on comparison between the anisotropy of magnetic susceptibility (AMS), feldspar shape preferred orientation (SPO) determined by optical reflexion goniometry and the mesoscopic fabric pattern. Two main magmatic foliations have been recognized which are associated with the local variations in the meter-scale. The widespread sub-horizontal, homogenous and strong foliation with NE dips is alternated with the vertical intensive foliation, predominantly NNW-SSE trending. The intensive fabrics are frequently sharply transposed into unaligned phenocrysts with rather chaotic fabric pattern resulting in overall complex interference patterns at outcrop scale. In addition, magmatic foliations tend towards parallelism with the margins of stoped blocks over a distance of one to several meters and exhibits meter-scale variations with respect to stoped blocks. The Lands End granite exhibits low degree of anisotropy of magnetic susceptibility (AMS) carried by biotite. In contrast with the magmatic fabrics, the AMS is characterized by the widespread homogenous subhorizontal foliations bearing the subhorizontal lineations trending WNW-ESE and N-S. Importantly, the overall AMS fabric is in close correspondence with D3 structures of the host rocks interpreted to being associated with the emplacement age. In order to characterize the pattern and intensity of the preferred orientation of minerals we have compared the orientation tensors from the AMS and from the direct fabric measurements of feldspars on optical goniometer. The comparison revealed strong concordance between the orientation of AMS lineation and feldspar maximum eigenvector in zones of high intensive subhorizontal feldspar fabrics. However, strong deviations of the AMS and feldspar fabric were observed in the zones of vertical mesoscopic fabrics and further from the margins of the host rock. We assume that individual subfabrics reflect different increments of strain history of cooling magma. The feldspar fabric may be related to construction of the magma chamber incorporating the large number of strain increments while the AMS reflects only final strain increment controlled by host rock and granite margin mechanical coupling.

Keywords: magmatic, fabrics, granite

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ASI005 **Poster presentation** **3102**

Fabric transpositions in highly viscous extrusive domes - AMS Analogue Modeling Study

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Analogue modeling using anisotropy of magnetic susceptibility (AMS) was employed to study the internal fabric pattern within highly viscous extrusive domes. The obtained fabric pattern was compared with the natural model example of trachyte extrusion in the Česk Středohoř Mountains <st2:citation w:st="on">(Czech Republic)</st2:citation>. Colored plaster of Paris was homogeneously mixed with fine-grained magnetite and hydraulically squeezed from a circular conduit through a 10 cm thick sand layer on its surface. AMS of solidified plaster models up to 50 cm in diameter was measured in 1 cm hexagonal grid. Several experiments with various thickness of plaster mixture (plaster: water mixing ratio) were created. Increasing mixing is proportional to the aspect ratio of the final model domes. Plaster rheology revealed thixotropic and pseudoplastic behavior, which is given by framework collapse and parallel alignment of platy-like plaster particles in the suspension during flow. Thin extrusions (low mixing ratio) result in a single emplacement event and show axisymmetrical shape. In contrast, thick extrusions <st2:citation w:st="on">(high mixing ratio)</st2:citation> show a distinct transition from continuous growth and symmetric radial spreading into pulse-like regime, marked by asymmetrical emplacement of successive lobes. This transition is typical for highly viscous extrusive domes undergoing degassing and crystallization at the upper levels of magmatic conduits (Voight et al., 1999). Internal fabric of thin extrusions exhibits a relatively simple pattern, similar to that obtained from silicone putty experiments (e.g. Merle 1998). The basal part of the extrusion shows lineations trending radially from the center, imbricated foliations and oblate fabrics associated with radial spreading. The upper part shows lineations perpendicular to the direction of spreading and prolate fabrics resulting from circumferential stretching. The thick extrusions revealed more complex internal fabrics, where successive lobe emplacement leads to transposition of fabrics in already emplaced and rotated lobes. This transposition is induced by inflation of new spines above the sand layer horizon and their motion from the central area. The internal fabric of the newest lobe shows a plug-like flow imbrication with steep fabrics along its margins. The older lobes around the central part show similar fabric pattern and intensity to the new lobe, but close to the contact, intensity of AMS fabrics decreases. This is similar to the fabric pattern measured in the trachyte extrusion in the Česk Středohoř Mountains characterized by a folded zone with relatively low intensive AMS fabrics around a central cupola. Merle, O. 1998. Internal strain within lava flows from analogue modeling. Journal of Volcanology and Geothermal Research 81(3-4), 189-206.Voight, B., R. S. J. Sparks, et al. 1999. Magma flow instability and cyclic activity at Soufriere Hills Volcano, Montserrat, British West Indies. Science 283(5405), 1138-1142.

Keywords: analogue, modeling, extrusions

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ASI005 **Poster presentation** **3103**

Integration of AMS and paleomagnetic data: a preliminary study in Monchique Massif (Southwest Portugal)

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Some previous paleomagnetic works have been carried out in Monchique Massif (southwest Portugal). At least three different paleomagnetic directions have been published in previous papers. However a consistent direction for the Massif wasnt yet established. The Monchique upper cretaceous pluton (72 Ma Ar/Ar age), covering a surface area of 80 km2 with an east-west elongate shape, is essentially a nepheline syenite intrusion into Carboniferous Flysh units.The main goal of this study is to investigate the possibility of a relationship between the Anisotropy of Magnetic susceptibility (AMS) and the paleomagnetic directions in the Monchique Massif. In order to clarify this issue, a total of 102 oriented core samples from 12 stations, for which the paleomagnetic direction was already been determined, were measured using an Agico Kappabridge (KLY-4S) susceptometer (Laboratrio the Petrofsica, of Geology Department of Porto University) working at a low alternating inductive field (4x10-4 T, 920 Hz) with a sensitive of about 2x10-7 SI. Each AMS measurement yields the magnitude of the three principal axes of the AMS ellipsoid (K1≥K2≥K3) as well their declination and inclination with respect to geographical frame. The bulk magnetic susceptibility is given by (K1+K2+K3)/3 and measured values are comprised between 1.18 and 62.47X10-3SI. The anisotropy degree (P=K1/K3) was also calculated and ranges from 1.031 up to 1.174. The three highest anisotropy degrees (1.174, 1.103 and 1.102) correspond to the sites where the paleomagnetic directions are deflected towards the expected paleomagnetic direction. This suggests that at least for these three stations the paleomagnetic directions could have been influenced by the AMS directions.

Keywords: monchique, ams, paleomagnetism

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ASI006 **3104 - 3115**

Symposium
Acquisition and stability of natural and laboratory-produced remanence

Convener : Dr. Richard Elmore
Co-Convener : Dr. David Heslop, Dr. Leonardo Sagnotti

This symposium will address a variety of issues related to the stability of both natural and laboratory remanences. We encourage any contributions on how rocks acquire natural remanent magnetization, including studies of primary remanences such as detrital remanent magnetizations. Remagnetization is tangible evidence of an important chemical, thermal, or tectonic event in the history of the rock and we welcome contributions on any aspect of remagnetization, including the origin of syntectonic remanences, remagnetization related to bolide impacts, and rock magnetic characterization of chemical remanences. Studies of laboratory remanences, including isothermal remanence acquisition, backfield measurements, and anhysteretic remanence are also encouraged as fundamental analytical tools in paleomagnetic and rock magnetic investigations

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ASI006 **Oral Presentation** **3104**

Remagnetisation as evidence of a natural thermal event in the history of the lignite-clay sequences: magnetic signals from porcelanites (Dacian Basin, Romania)

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The intervention of the porcelanites within the Pliocene lignite-clay sequences located in the Western Dacian Basin (Romania) is easily noticed in the coal quarries, the porcelanites generally showing the consistence and the red colour of the bricks. These new rocks (porcelanites, porcelanite-like rocks, clinkers) are produced by baking, sometimes by melting/fusing of clays (in this case), during intermittent burning of certain coal beds (with petrographic-mineralogic availability for autoignition). The (palaeo)magnetic parameters measured on fresh and baked clays showed a clear-cut differentiation of two states of the magnetic recording medium (MRM). The rock magnetic signal received from the original (Pliocene) clays was defined by low amplitude. The initial magnetic susceptibility (kin) exhibits values ranging between 125x10E-06 and 250x10E-06 SIu., rarely exceeding 940x10E-06 SIu. The total natural remanent magnetisation showed low intensity values (In), mostly below 1 mA/m, seldom higher than 30 mA/m. The rock magnetic signal sent by the baked clays, representing the thermally-disturbed MRM, is distinct from the signal characteristic for the original clays (i.e. the initial/thermally non-affected MRM). The kin has considerably increased; comparing with the fresh/original clays, it is one to three magnitude orders higher. With regard to the anisotropy of magnetic susceptibility (AMS), the enhancement of several AMS parameters has been observed; e.g. F (magnetic foliation) and P (anisotropy degree) increased from 1.03 1.05 (for the fresh clays) up to 1.10 1.20, sometimes 1.30 1.40 (for the baked clays). The porcelanite-like clays and the porcelanites, newly formed at the expense of initial/original clays (characterised by a detrital remanent magnetisation), acquired an important thermoremanent magnetisation. High intensity values (In), mostly between 1 7 A/m, occasionally reaching 7.982 A/m, were recorded. The palaeomagnetic signal showed the essential modifications suffered by the MRM due to the post-depositional thermal perturbations; changes of the geomagnetic record that had been fixed in the fresh/original rocks were produced. Thus, the thermally non-affected clays, characterising the original (initial) state of the MRM, have recorded a reversed polarity, whereas the porcelanites, characterising the modified (subsequent) state of the MRM, located in the vicinity of the fresh clays, have printed a normal polarity of the geomagnetic palaeofield. The former polarity zone was assigned to the Gilbert Chron, namely to the lower part of the C2Ar Subchron (ATNTS-2004; 4.187 3.596 Ma), whereas the latter was assigned to the Brunhes Chron (0.781 0.00 Ma). Thus, deposits of rocks, spatially situated in an adjacent position, are temporally placed at a distance of about 3.5 Ma. Besides, significant magnetic anomalies produced by the porcelanite deposits (amplitudes up to 1880 nT) were recorded with the Geometrics magnetometers. All these (palaeo)magnetic signals represent evidences of the natural thermal event produced in the history of the lignite-clay sequences investigated in the South-West Romania.

Keywords: remagnetisation, lignite clay sequence, porcelanite

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ASI006 **Oral Presentation** **3105**

Paleomagnetism of the Central Metasedimentary Belt, Grenville Province, Ontario, Canada: Thermal or Chemical Remagnetization?

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We have carried out a paleomagnetic traverse across the Central Metasedimentary Belt (CMB) of the Precambrian Grenville Province in southern Ontario, linking with an earlier traverse of the Central Gneiss Belt (CGB) and the CMB Boundary Zone (CMBBZ). We sampled 54 sites in five terranes, (from east to west) the Frontenac (Fr), Sharbot Lake (SL), Mazinaw (Mz), Elsevir (El) and Bancroft terranes. 40Ar/39Ar thermochronometry in a similar CMB traverse documented differential unroofing of different terranes and slow cooling (1.0-1.5C /Ma) along parallel temperature-time (T-t) paths offset by 50-100 Ma for the Fr, Mz and El terranes and the CMBBZ (Cosca et al., Contrib. Miner. Petrol., 110, 211-225, 1992). Around 1000 Ma, inferred burial depths were 20 km for the CMBBZ, 15 km for El, >20 km for Mz, 10 km for Fr, and transitional (12-16 km) for SL. The very different hornblende, phlogopite, muscovite and biotite 40Ar/39Ar ages of neighboring terranes should have a counterpart in their paleomagnetic results because 1100-850 Ma was a time of rapid paleolatitude shift. However our results do not bear this out. Fr, SL and Mz have similar reverse-polarity paleopoles in the central part of the Grenville polar wander track, while Fr and SL normal-polarity poles are typical 980 Ma Grenville A poles. The Fr terrane cooled through 500C around 1100 Ma but Fr poles do not resemble 1100 Ma Keweenawan poles. The Mz terrane cooled through 500C around 950 Ma but Mz poles seem to be older than 980 Ma. Our El mean pole and some Fr poles resemble Grenville B poles (about 820 Ma). We conclude that although the different terranes had their 40Ar/39Ar ages reset thermally as they passed through critical isotherms (approximately 500C for hornblende) at different times during differential uplift, they were not thermally remagnetized at these same times. Instead Fr, SL and Mz (and much of the CMBBZ and CGB) apparently were remagnetized in a narrow time window between 1000 and 950 Ma, presumably by a widespread chemical/ thermochemical event. A younger event, ca. 820 Ma, affected El and part of Fr, at the western and eastern extremes of the traverse, but not other areas in between. The lack of correlation between 40Ar/39Ar ages and paleomagnetic results for Fr, SL, Mz and El is serious because it casts doubt on the thermochronometric age calibration of the Grenville APWP, which is based on the assumption that the magnetic and isotopic systems respond in similar ways to slow cooling during uplift so that their blocking temperatures can be directly compared. The only way to reconcile the most discordant results those of Fr is to suppose that Fr acquired its A magnetization around 1100 Ma before it docked with Laurentia. While this is geologically reasonable, the match between the Fr poles and 950-1000 Ma Grenvillian poles seems too close to be coincidental.

Keywords: remagnetization, thermochronometry, grenvilleprovince

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ASI006 **Oral Presentation** **3106**

Paleomagnetic and rock-magnetic study of folded Lower Carboniferous carbonates, NW Montana and SW Alberta

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Paleomagnetic and rock magnetic analysis of Carboniferous carbonates in the Sawtooth Range, NW Montana and the Livingstone Range in SW Alberta was performed to test if there is a link between folding styles and the acquisition of an orogenic remagnetization. A previous study in the Sawtooth Range, Montana found that Carboniferous carbonates within fault propagation folds contain a syntilting characteristic remanent magnetization (ChRM) whereas, a buckle fold and tilted (thrusted) rocks contain a similar pretilting ChRM. Paleomagnetic cores were drilled in both limbs of two fault propagation folds along Oldman River in Alberta to test this observation. The rocks contain a ChRM that resides in magnetite based on maximum unblocking temperatures (~500-540C) as well as hysteresis properties. The ChRM has southerly declinations and steep up inclinations or an antipodal direction with northerly declinations and steep down inclinations. Tilt tests indicate that the ChRM is pre- to early syntilting. Additional sampling is necessary to test if the results are consistent with what was found in Montana. The paleopoles suggests remanence acquisition in the Cretaceous to Early Tertiary, consistent with the results from Montana. The ChRM is not thermoviscous in origin based on a comparison of the maximum unblocking temperatures with the low burial temperatures and is interpreted as a chemical remanent magnetization (CRM). Some of the sites at Oldman River also contain a second intermediate temperature component that is syntilting and interpreted to be thermoviscous in origin. The CRM is most common in dark gray carbonates of the Mount Head and Etherington formations. These formations are hydrocarbon reservoirs in the subsurface, which suggests the possibility that there is a connection between the CRM and hydrocarbon migration. Preliminary high-field rock magnetic data from the Alberta samples as well as from the carbonates in Montana show that many samples display wasp-waisted hysteresis loops suggesting that the rocks contain magnetic grains with a mixture of grain sizes. This preliminary work does not reveal any differences between the rocks that contain pretilting versus syntilting ChRMs. An interesting feature of the hysteresis data is that it plots below the commonly-observed remagnetization line on a plot of the ratio of remanent magnetization (Mrs) over satuation magnetization (Ms) verses the ratio of remanent coercivity (Hcr) over coercivity(Hc). These results are under investigation and will be tested by the acquisition of additional hysteresis data.

Keywords: paleomagnetism, rock magnetism, orogenic remagnetizations

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ASI006 **Oral Presentation** **3107**

Micrometeorites influx: a possible bias on the detrital remanent magnetization of sediments

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Micrometeorites are terrestrially collected extraterrestrial particles smaller than about one millimeter. They constitute the main part of the mass flux of extraterrestrial matter accreted on Earth. Most of them melt during atmospheric entry and are called cosmic spherules. They can be found in deep-sea sediments, in Greenland seasonal lakes, in Antarctic ice and aeolian sedimentary traps, and in desert sands. Magnetite is present in micrometeorites before the atmospheric entry, and it is also abundantly produced from the metal bearing phases in cosmic spherules. Therefore, they may have an effect on the magnetic properties of sediments they deposited in. In this study, we carried out magnetic measurements on 278 cosmic spherules and 4 unmelted micrometeorites from different collections. The natural remanent magnetization (NRM) and the isothermal remanent magnetization (IRM) have been measured, followed by alternating-field or thermal stepwise demagnetization. The magnetic susceptibility was also measured. Those measurements provide an average value for the specific NRM intensity of 12 mA.m/kg. The NRM is a stable thermal remanent magnetization (TRM) acquired after the atmospheric heating. Assuming a known micrometeorite flux, we calculated the probability that a micrometeorite significantly contributes to the NRM of a standard paleomagnetic sample (U-channel or standard 10.8 cc core) as a function of the sedimentation rate and the NRM intensity of the sediment. The calculation shows that a possible bias on NRM direction due to micrometeorites is expected for a NRM intensity less than 10-5 A/m (respectively 10-4 A/m) with a sedimentation rate of 10 m/Myr (respectively 1 m/Myr). Conversely, the contribution of micrometeorites to the magnetic susceptibility of the sediment appears negligible, even for very low sedimentation rates. These results show that micrometeorites are a candidate for explaining possible anomalies in the direction of the NRM of sediments.

Keywords: micrometeorites, drm, bias

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ASI006 **Oral Presentation** **3108**

Post impact remagnetizations in the Devonian Alamo Breccia, Nevada

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The Late Devonian (Frasnian) Alamo Breccia Member Guilmette Formation (central Nevada), has been interpreted as a megasedimentary deposit formed by the ejecta curtain and tsunamis after a bolide impact event on or near the shallow marine carbonate platform. A modified paleomagnetic conglomerate test was conducted on the clasts in the unit to aid in determining the origin of the impact related breccias. The results of the conglomerate test show that the magnetization is post-depositional, and that the breccia has been remagnetized by two or three secondary magnetizations. At most locations the rocks contain a characteristic remanent magnetization (ChRM) with southeasterly declinations and shallow to moderate negative inclinations. The ChRM is interpreted to reside in magnetite. A tilt test indicates that the ChRM is pre-Tertiary tilting. A wide range of declination values suggests that that some locations my have experienced vertical axis rotations. The pole position suggests remanence acquisition in the late Paleozoic. This magnetization is similar to that found by other workers in central Nevada. The ChRM is interpreted to be a chemical remanent magnetization (CRM) and may be related to orogenic fluids which migrated during the late Paleozoic. At one location (Tempuite Mtn.), the rocks contain a pervasive remagnetization with a northerly declination and a steep down inclination that is interpreted to reside in magnetite and to be Tertiary in age. This magnetization may be related to hydrothermal mineralization in and around Tempuite Mtn. Many locations also contain an intermediate temperature component with northerly declinations and steep down inclinations, interpreted to reside in pyrrhotite. This magnetization is Tertiary in age and is interpreted to be thermoviscous in origin. All of the magnetizations found in the unit are interpreted to be related to diagenetic or thermal events that are unrelated to the impact event.

Keywords: remagnetization, alamo breccia, diagenesis

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ASI006 **Oral Presentation** **3109**

Origin of remagnetizations at Sierra Madera Impact Crater, Trans-Pecos Region, Texas

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Sierra Madera, in Trans-Pecos Texas, is an exhumed complex impact crater containing both monolithic and mixed carbonate-siliciclastic breccias. Paleomagnetic data were gathered on both breccias and impact-deformed country rock to help shed light on the timing and origin of the magnetizations in the structure, and to constrain the date of the impact. Stepwise demagnetization reveals that two dominant magnetizations are present. One component has southerly declinations and steep up inclinations whereas the other has northerly declinations and steep down inclinations. The components are interpreted to reside in hematite. A modified conglomerate test was applied to determine whether the magnetization in the breccia clasts was acquired prior to, or after, deposition. All components fail the modified conglomerate test and were remagnetized following the impact brecciation. A reversal test on the data proved inconclusive; the data straddle the 95% confidence level. The pole for the component with southerly declinations falls near the Cretaceous-Early Tertiary portion of the apparent polar wander path, whereas the component with northerly declinations has a mid-Tertiary pole. Additional analysis is underway which will help to determine if the directions are antipodal or if two different components are present. A low temperature component with westerly declinations and moderate down inclinations interpreted to reside in pyrrhotite and/or magnetite is present in some breccias. This component has directions which aresmearedbetween the other components and may represent a vector addition. The remagnetizations are presumed to be chemical remanent magnetizations (CRMs) rather than thermoviscous remanent magnetizations based on the craters burial and temperature history. A potential mechanism for remagnetization is the circulation of intermediate temperature fluids through the structure immediately after the impact, or later in the Tertiary.

Keywords: remagnetizations, impacts, breccia

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ASI006 **Oral Presentation** **3110**

The anhysteretic remanent magnetization of interacting single domain particles

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The anhysteretic remanent magnetization (ARM) is widely used in rock magnetism and paleomagnetism because of its sensitivity to the domain state of magnetic particles and the close analogy to natural remanent magnetizations. On the other hand, the ARM shares with other weak-field magnetizations the property of being extremely sensitive to magnetostatic interactions. It is therefore desirable to model the ARM acquisition process in natural assemblages of magnetic particles and the effects of interactions. Direct micromagnetic calculations of the ARM are not practicable; therefore an analytical approach to the calculation of the ARM susceptibility of a system of interacting single-domain (SD) particles is presented. This approach is based on a complete solution of the kinetic equation of thermally activated particles, and on a statistical description of the interaction field, which can be easily extended to the calculation of other weak-field magnetizations. The ARM of SD particles is extremely sensitive to (1) the reversal mechanism of the magnetic moment, (2) thermal activations, and (3) magnetostatic interactions effects, which include the concentration and the distribution of the particles within a nonmagnetic matrix. SD magnetite particles are affected by interactions at a concentrations as low as 0.01% by volume, far below the nominal value of 1% commonly used as a rough upper limit for non-interacting systems. A concentration of 0.2% reduces the ARM of SD magnetite to 50% of the non-interacting value. The analytical model presented here also provides a direct means to calculate the effects of interactions on the anisotropy of ARM (AARM) in terms of geometrical parameters that describe an orientation-dependent distribution of particles in space, called "distribution anisotropy" is similar studies on the anisotropy of magnetic susceptibility. An anisotropic spatial arrangement of the particles, expressed by the dependence of the average particle distance on the orientation of the sample, produces a unbalance between positive and negative interaction fields that modulates the directional dependence of ARM intensity. The AARM of SD magnetite is adversely affected by interactions at concentrations >0.5%, where the anisotropy parameter displays a complex behavior that depends very strongly on the concentration, the coercivity and the geometric arrangement of the particles.

Keywords: arm, interactions, anisotropy

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ASI006 **Oral Presentation** **3111**

Early diagenetic greigite as recorder of the palaeomagnetic signal in the Mio-Pliocene sedimentary rocks of the Carpathian foredeep (Romania)

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During the Miocene-Pliocene, the Carpathian region represented the westernmost part of the so-called Eastern Paratethys, a palaeo-bioprovince that covered central and eastern Europe as well as parts of southwest Asia. Previous palaeomagnetic investigations provide a high-resolution magnetochronology for the sedimentary sequences of the Carpathian foredeep with a marked transition in magnetic carriers from iron oxides to iron sulphides, in the chron C3r. Here, we show by detailed rock magnetic investigations and scanning electron microscope (SEM) analyses that the major magnetic iron sulphide mineral is greigite. Thermomagnetic runs indicate an irreversible decrease in magnetisation with increasing temperature up to 400C and SEM observations indicate octahedral grain morphologies and Fe:S ratios that are indicative of greigite. Hysteresis loops have rectangular shapes, which are typical of single domain behaviour, with coercivity and coercivity remanence at values Bc = 35-45 mT and Bcr = 52-67 mT respectively. First order reversal curves diagrams have contours that close around single domain peaks with Bc values of 45-90 mT indicating magnetic interactions in the Romanian Carpathian foredeep samples. Consequently, isothermal remanent magnetisation (IRM) component analysis should be used with caution and skewed-to-the-left distributions should not be given physical meaning. We used the IRM fitting program of Kruiver et al. 2001 that is limited to symmetric distributions in the log-space. The preferred way of fitting the IRM acquisition curves appeared to be with a dominant coercivity component with a mean B1/2 ranging between ~70 and ~85 mT and a small dispersion (0.14-0.18 log units) indicating a narrow grain-size distribution. This component is interpreted as greigite. An additional coercivity component has smaller values for B1/2, usually between ~24 and ~35 mT with no physical meaning in the majority of cases. We thus argue that (most of) the greigite was formed under early diagenetic conditions, i.e. within 1000 years of deposition of the sediment in this setting, and that it thus can be considered as a reliable recorder of the palaeomagnetic signal. Positive fold test, inclination shallowing and two positive reversal tests are arguments for the near syn-depositional formation of this greigite. The appearance of greigite during Chron C3r (between 6.0 and 5.5 Ma) in the Carpathian foredeep is most likely related to regional tectonic and/or climatic events that reshaped the basin configuration and changed the palaeoenvironmental conditions.

Keywords: greigite, irm, early diagenesis

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ASI006 **Oral Presentation** **3112**

Small circle methods in paleomagnetism

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A remanence small circle is the path on which the remanence moves during tilt correction. It is defined by the bedding attitude of the site and the presumption of a horizontal tilt axis parallel to bedding strike. Small circle methods are the key to the tectonic interpretation of synfolding remanences, but they can also be used for prefolding remanences, e.g. to cross-check conventional fold tests and to examine tectonic deformation in more detail. There is moreover the feature of the small circle distribution: remanence vectors, acquired at different stages of tilting, will be distributed on a small circle parallel to the pi-circle of bedding. Such small circle distributions are found in directionally folded sequences, but also in single sites and even in individual specimens, a point which should be kept in mind already during the identification of the remanence components. Small circle methods shall not replace any conventional method in paleomagnetism. They are geometrically alternative to tilt correction and, applied in addition, they allow for a more detailed and more reliable interpretation of the data.

Keywords: paleomagnetism, small circle, directionally folded sequence

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ASI006 **Poster presentation** **3113**

Multiple antipodal remanence components in the Skye Lava (UK): complex thermal and chemical history and self- reversals

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Large Igneous Provinces, overwhelmingly of basaltic affinity are the surface expressions of catastrophically rapid dissipation of large quantities of internal heat. With an estimated volume of ca 107 km3, the North Atlantic Igneous Province (NAIP) represents the third largest magmatic event on Earth for the last 150 Ma. The formation of the NAIP has been linked to the proto-Icelandic plume through paleogeographic reconstructions and geochemical observations. However, despite active research focus since the late 1980s, the temporal and physico-chemical ties between NAIP rocks, hotspot motion and continental break-up have not been demonstrated to fit a single regionally applicable and consistent geodynamic model. Therefore, in the framework of reinvestigating the paleomagnetic directions of the British Tertiary Igneous Province (BTIP), a sampling of ~200 cores (19 sites) in the lava pile of the Isle of Skye (Scotland) has been undertaken. Although 80% of the samples showed 'expected' behaviour with one or two components, three sites (20%) exhibits complex magnetization with up to five well constrained mostly antipodal components. This peculiar behaviour is only triggered trough careful stepwise thermal demagnetisation. Alternative field demagnetisation on companion core usually exhibits only two components. We are able to rule out acquisition of stray fields in laboratory equipment as an explanation and are left with an open question as to the origin of these multiple directionally opposed components. Variation in remanence stability under thermal and alternating field demagnetisation may reflect the combined action of two alteration processes, namely deuteric oxidation and regional alteration, which could have created secondary minerals that have the ability to self-reverse under specific conditions. It has been demonstrated for the Skye lava that regional hydrothermal activity widely occurs and that it can alter the magnetic properties of titanomagnetite in low deuteric oxidation states to such an extent that thermally stable magnetic phases with a single Tc above 500˚ may appear. The history of alteration of these lavas will be investigated and discussed as well as alternative explanations including multiple self-reversals, and other possibilities of episodic chemical or thermal remagnetisation.

Keywords: skye, remagnetization, basalts

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ASI006 **Poster presentation** **3114**

Natural remanence carried by lamellar magnetism

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Large and stable negative magnetic anomalies in Sweden, Norway and the Adirondacks,New York, are related to rock units the magnetic fraction of which consists primarily of ilmenohematite. It has been suggested that the unusual magnetic stability of these rocks result from lamellar magnetism. This is a new type of magnetic remanence,which is carried by uncompensated magnetic layers at interfaces between nanoscale exsolution structures of antiferromagnetic hematite and paramagnetic ilmenite. Here we present the first direct proof that this lamellar magnetism indeed is responsible forthe natural remanent magnetization (NRM) of rocks from Modum, Norway. Our argument is based on the previous observation, that in these rocks the cooling of a room temperature SIRM to 10 K - which is well below the ordering temperature of ilmenite(57 K) - leads to a large shift of the low temperature (LT) hysteresis loop. This can only be explained by exchange bias due to exchange coupling across the hematite-ilmenite interfaces. In a different experiment we now cooled untreated samples, carrying the original NRM, to 10 K and then measured the hysteresis loop. In several independent samples we also observe a large shift of the hysteresis curve. Thus, exchange bias develops also from the untreated NRM. This observation proves that the moments, which carry the NRM, also participate in the exchange coupling at thehematite-ilmenite interfaces. Therefore, the NRM is not carried by defect moments or stress induced moments, which occur in normal bulk hematite. A closer look at the NRM induced LT loops shows that exchange bias acts in both field directions, though one direction is clearly predominant. This observation can be interpreted as a frozen equilibrium of different proportions of oppositely directed lamellar moments.

Keywords: lamellar magnetism, nrm, ilmenohematite

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ASI006 **Poster presentation** **3115**

Viscous magnetization in pseudo-single domain magnetite: Results from first principle micromagnetic modelling

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We present a quantitative calculation of viscous remanence acquisitionand decay in pseudo-single domain magnetite particles. The calculationis based on a statistical evaluation of exactly determined energybarriers between local energy minima (LEM). This requires to find allpossible LEM states for a given particle geometry, and then to determinethe energy barriers between all pairs of these LEM states. To achievethe latter, we developed a fast relaxation algorithm for finding theoptimal transition paths between two LEM states in a three-dimensionalmicromagnetic model. The algorithm combines a nudged elastic bandtechnique (Dittrich et al., 2002; Henkelman et al., 2000) with actionminimization (Berkov, 1998). However, the statistical evaluation of viscous magnetization acquisitionand decay for a particular cubic pseudo-single domain (PSD) magnetiteparticle requires to calculate all energy barriers between 60 differentlocal energy minima. All optimal transition paths between them have beennumerically calculated to obtain the respective transition probabilitiesin zero and weak external field. These probabilities in turn are used toset up a linear matrix differential equation for viscous decay andremanence acquisition. Solving this matrix equation enables us to modelviscous magnetization curves for arbitrary initial states over all timescales. For our PSD particle the calculations show anunexpected intermediate remanence overshooting during VRM acquisition. This results from the fact that the decay of fieldaligned flower states into vortex states is slower than the decay ofantiparallel flower states. This leads to an intermediate residualflower state moment which is larger than the finally reached pure vortexmagnetization. Another important outcome of the viscosity calculation isthe extremely high stability of the finally acquired VRM. While itsacquisition occured within about 10^3 s, zero-field decay of VRM sets inonly beyond 10^13s. This difference between acquisition and decay is dueto the asymmetry of the energy barriers. Such astable VRM also cannot be thermally demagnetized at low temperatures andtherefore provides a major source of persistent magnetic overprint inpaleomagnetic studies.

Keywords: viscous magnetization, micromagnetics

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ASI007 **3116 - 3134**

Symposium
Magnetic signature of past and present environmental changes

Convener : Dr. Ann Hirt
Co-Convener : Dr. Monika Hanesch

Iron is one of the most common elements in soils and sediments and the concentration and mineralogy of magnetic iron minerals may constitute a sensitive indicator of local environmental conditions. Iron is also an important element in biological processes that are enviromentally sensitive. Magnetic methods have been used as a proxy for environmental change over the last 20 years so that the applicability of magnetic methods can be now evaluated. Examples of large data collections include loess and lake sediments in which various magnetic parameters have been linked to change in climate; or the magnetic signature in soils or leaves, which has been used to quantify atmospheric pollution. In light of the improvement of instrumentation and methodology that gives new perspectives for deeper knowledge about the relations between different magnetic properties of the environmental materials. In some cases these magnetic parameters provide unique informations which are not available with other methods. This symposium will address the following topics: 1) evaluation of techniques that are used to obtain the magnetic signature of environmental change in various natural materials such as soils, sediments or vegetation; 2) the importance of biomagnetic processes in environmental magnetism; and 3) case studies and palaeoenvironmental reconstructions where magnetic studies contribute information that would be otherwise unavailable

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ASI007 **Oral Presentation** **3116**

Geomagnetic secular variations recorded in the sediment cores from Lake Qarun, Egypt.

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4 sediment cores (length 4-6 meters) were collected from Lake Qarun, Egypt. About 800 of 7-cc cube specimens were obtained from the four cores (total length ~ 20 m). Apart from the top 30-50 cm of each core, these sediment cores have very stable remanent magnetization with the average MDFs of 15-20 mT. The characteristic remanent magnetizations were isolated from more than 70 % of the cube specimens by using orthogonal plots of the demagnetization curves of the NRMs. Depth variations of the declination and the inclination of the characteristic remanence clearly indicate the long-period paleomagnetic signal is recorded in all four cores. In addition to the NRM measurement, the initial magnetic susceptibility, ARM and SIRM measurements were made for all the samples. The patterns of the depth variations of these magnetic properties among the present cores resemble well with each other and the intercore chronological correlation is carried out using these properties, in which converting functions are calculated that relate the depth-scale of each core to a selected master core. The second core was chosen as the master core because of its length and possible stable sedimentation condition. This correlation suggests that the sedimentation condition for the first and second, sampled near the deepest part of the lake, were stable during the period covered by the entire section of the cores. On the other hand the result for the third core reveals a rapid increase of the sedimentation rate during the recent time and a large deformation of the sedimentary layer with a thickness of about 1.5 m below this level, which is probably related with this change of the sedimentation rate. And the result from the fourth core, cored at a shallow depth of 5.2 m, indicates that the water level of the lake was once lower than the bottom of this site. For the relative paleointensity measurement from sediment cores, NRM intensities should be normalized by a factor to represent the amount of magnetic carrier in each sample. The initial magnetic susceptibility, ARM intensity, and SIRM can all be candidates as the normalization factor. In the present study, the NRM/ARM ratio is used as a measure of the relative paleointensity because of the apparent no correlation between the NRM/ARM ratio and the susceptibility. Pattern of the depth variations of these ratios are similar with the temporal variation curve of the paleomagnetic intensity estimated from the archaeomagnetic studies in Egypt and, hence, we could infer the depth-age relation of the master cores from the comparison of these two set of curves. The depth-age relation indicates that the bottom of the second core correspond to the age of about 7000 years before present, and the sedimentation rate for this master core has been approximately constant since 7000 years BP to the present. The depth-age relations for the other cores can be obtained from the conversion functions shown above. Since the age-depth relation for all the present cores are determined, the continuous record of the secular variations of the direction and the intensity of the geomagnetic field during the last 7000 years are reproduced by stacking the results from the present cores. The estimated variations are coherent with the previous estimates by the archaeomagnetic studies. Moreover, the temporal variation of the sedimentation environment around Lake Qarun can be estimated once the age-depth relations are established.

Keywords: lake sediments, secular variation, egypt

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ASI007 **Oral Presentation** **3117**

Use of paleosols and soils magnetic signal as a climate index

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A comparison of the index of potential water storage (PWS) with the magnetic signal of soils and paleosols from different regions of the world suggests the existence of climatic thresholds that affect the formation, preservation or depletion of ferrimagnetic minerals. Soils characterized by a positive PWS are wetted during an important part of the year, creating an appropriate environment that favors the depletion of ferrimagnetic minerals due to mainly reductive dissolution. Such soils are characterized by a depletion of detrital ferrimagnetic minerals, as in Argentinean soils and paleosols. On the other hand, a negative PWS prevents highly reducing conditions in the soil, and the detrital ferrimagnetic minerals are preserved. The environmental conditions of these soils allow the formation of (superparamagnetic) pedogenic minerals, together with the preservation of lithogenic minerals. These conditions produce a net magnetic enhancement of the soil, as observed in Russia and China. A second threshold in PWS could be at a positive value.

Keywords: paleosols, loess, magnetism

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ASI007 **Oral Presentation** **3118**

Magnetic signature of sediments from the Adriatic shelf and the history of sediment supply during the Holocene

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Rapidly-deposited marine sediment accumulated along the western Adriatic shelf has been investigated by paleomagnetic and rock-magnetic methods. The goal of this work is to reconstruct sediment supply fluctuations occurring during the Holocene and particularly during the last sea level highstand above the maximum flooding surface (5.5 kyr. B.P.). Here we present results obtained from five cores collected along the shelf of the Adriatic Sea. Four of the cores (Prad2-4; KS02-246; CSS00-23 and AMC99-01) were studied in the central part of the basin in water-depths from 56 to 250 m. An additional core (CSS00-7) with coeval sediment was retrieved in the southern part of the basin. Radiocarbon dating based on planktic and benthonic foraminifera was used to develop a detailed age-depth model. Magnetic measurements (K, NRM, ARM, IRM) were carried out on U-channel samples at the laboratory of the University of California at Davis using an 2G Enterprises automated cryogenic magnetometer. Rock-magnetic parameters indicate a homogeneous magnetic mineralogy dominated by fine-grained magnetite. The magnetic signature of the late Glacial-Holocene transition is characterized by a significant decrease in grain-size whereas the first part of the Holocene is dominated by reductive diagenesis corresponding to the deposition of sapropel S1. Increasing ARM values in the Holocene sediments may reflect a change in the source of the magnetic minerals, but also an increasing contribution of bacterial magnetite. Cyclic oscillations in both concentration and grain-size related magnetic parameters reflect changes in sediment supply during the last 5 kyr. The sediment deposition increased during the last few centuries as a response to changing paleoceanographic conditions and/or anthropic impact. After AF cleaning, the NRM directions show a characteristic and primary magnetization that can be considered representative of secular variation of the Earth magnetic field. Correlations of magnetic parameters using the observed features in the secular variation record will help to detail the history of sedimentation during the Holocene with an independent proxy bearing a chronological resolution up to decades.

Keywords: paleomagnetism, adriatic, holocene

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ASI007 **Oral Presentation** **3119**

Polar ice magnetization: results from Vostok ice core (Antarctica) and comparison with North Grip (Greenland) ice

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Measurements of isothermal remanent magnetization (IRM) in Greenland ice spanning the last glacials and interglacials have shown that ice samples contain a measurable concentration of magnetic minerals which are part of the atmospheric aerosol. Assuming that the source materials do not change, the concentration of magnetic minerals should be proportionally related to the measured concentration of dust in ice. We have indeed found a consistent linear relationship with the contents of dust. However, the ice magnetizations do not show the same range of variability as the dust concentration. The linear relationship between ice magnetization vs. dust concentration has an offset, which when extrapolated to zero dust concentration, would seemingly indicate that a significantly large magnetization corresponds to a null amount of dust in ice. Thermal relaxation experiments have shown that magnetic grains of nanometric size carry virtually all the uncorrelated magnetization. Magnetic measurements in Antarctic ice cores confirm the existence of a similar nanometric-size magnetic fraction, which also appear uncorrelated with aerosol concentration. The magnitude of the uncorrelated magnetization from Vostok is similar to that measured in NorthGRIP ice. Measurements of IRM at 250K temperature suggest that SP magnetic particles are in the size range of about 7-17 nm, which is compatible with the expected size of particles produced by ablation and subsequent condensation in the atmosphere of meteorites. The concentration of extraterrestrial material in NorthGRIP ice was estimated from the magnetic relaxation data in 0.780.22 ppb for Greenland, in good agreement with results based on iridium concentrations in NorthGRIP ice samples. A virtually identical concentration of 0.530.18 ppb has been measured in Vostok ice core.

Keywords: ice magnetism, meteoric smoke, dust

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ASI007 **Oral Presentation** **3120**

Magnetite weathering in a vertisol with seasonal redox dynamics

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We investigated samples from a Vertisol developed in a flat lying flood plain in the savannah woodland of southern Mali. The soil is characterized by a water regime governed by regularly occurring wet and dry seasons. The soil was subdivided into four horizons Ap, A2, A3, and Ag which differed in the content and speciation of the redox sensitive elements Mn and Fe. The redox cline is indicated by the minimum concentration of Mn in the A3 horizon. Dithionite-extractable Fe (Fe_d), which is a measure for the content of crystalline ferric oxides, is about two times higher in the Ap and A2 than in the lower horizons. The oxalate-extraction (Fe_ox), indicating poorly crystallized ferric oxides, exhibits a maximum in the Ag and a minimum in the A3 horizon. The ratio of Fe_ox/Fe_d decreases within the profile and reaches a value of 0.96 in the Ag horizon. Such a high value in the gleyic horizon suggests that almost all ferric oxides are present in a poorly crystallized form. These chemical data provide evidence for a longer seasonal waterlogging in the A3 and the Ag than in the upper two horizons. Within the profile the magnetic susceptibility (χ) varied between 5.5 x 10-7 m3kg-1 in the Ap and 1.6 x 10-7 m3kg-1 in the A3 horizon. The values of χ were about a factor of four higher in the upper two horizons. Magnetization (M) versus applied field (B) curves exhibited hysteresis loops characteristic for a low coercivity phase with a closure field of less than 0.5 T. The coercivity force (Bc) was similar in the upper two horizons and was increased by about a factor 2 in the A3 horizon. A similar trend was found for the remanence of coercivity (Bcr). The ratio of Bcr to Bc was higher in the upper two horizons. The ratio between the remanent magnetization Mr and the saturation magnetization Ms was more than a factor of 2 higher in the two lower horizons. The first-order reversal contour (FORC) plots indicated a larger contribution of particles with higher Bc in the lower two horizons. All these magnetic data reveal a decrease in the magnetite content and a larger contribution of smaller grains in the A3 and the Ag horizon. Considering the soil chemical data, this magnetic pattern can be explained by the seasonal fluctuation of the watertable. The pronounced magnetite dissolution in the lower horizons of our Vertisol can be explained by a seasonal interchange of surficial maghemitisation under oxic conditions and microbially induced reductive dissolution of this maghemite layer. Furthermore, the present occurrence of magnetite throughout the profile and the evidence for rather constant soil formation factors during the last 10000 years suggests that even under these conditions magnetite dissolution is a slow process.

Keywords: soil, magnetite, dissolution

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ASI007 **Oral Presentation** **3121**

Magnetic properties of brown soil profile containing archeological site

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We examined magnetic properties of brown soil profile containing archeological site with remnants of an ancient kiln or fireplace. All magnetic parameters of burnt soil were changed when compared with untouched soil profile taken near by. Magnetic mineralogy changed gradually from hematite in the topsoil to maghemite with decreasing Tb within the overheated layers. The final product is magnetite occurring at the base of a kiln. The border between the bottom of a kiln and the loess beneath is sharp. Within the layer of a few centimetres magnetic mineralogy changed from magnetite to hematite. Such abrupt passage is observed for all magnetic parameters. The upper border between overheated and fresh topsoil is also well marked in spite of more moderate transition. X, Ms, SIRM and ARM increased gradually starting from the depth of 30 cm until 100 cm, then all these parameters abruptly decreased to the values characteristic for the loess of unheated soil profile. Coercivity of remanence decreased for overheated soil in comparison with soil above and beneath. The change in mineralogy within the overheated layers is well demonstrated by twofold relationship between Hcr and such magnetic parameters as susceptibility, magnetization and remanence. The comparison of K(T) and SIRM(T) curves for burnt and undisturbed soils lead to the conclusion that the highest temperature and the deepest deficit of oxygen occurred at the base of a kiln while burning. At this depth the process of reduction was completed and resulted in creation of magnetite.

Keywords: magnetic properties, burnt soil, archeological site

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ASI007 **Oral Presentation** **3122**

Magnetic signature in a well-characterized Podzol

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A typical feature of Podzols is the vertical translocation of Fe and Al together with organic matter within the soil profile. Podzols are characteristic of cold to temperate-humid climate with high precipitation, where chemical weathering and leaching in the presence of organic ligands at very acidic soil pH are important pedogenic processes. Podzols are typically found under coniferous forest on poorly-buffered parent materials such as sandstone or granite. If iron transport occurs within the Podzols, this should be reflected in the magnetic signal in the soil. We have examined the magnetic properties of a Podzol profile that displays no redoximorphic features to gain insight into how geochemical processes affect magnetic mineralogy. The investigated profile developed on the Triassic Buntsandstein, a hematitic red sandstone. Immediately under an organic rich horizon (O, Ah), the profile has a well developed eluvial (E) horizon, followed by humic and sesquioxide-rich B-horizons (Bh, Bs), which are enriched in iron and aluminum. These are underlain by a weathered B-horizon (Bw) and the parent material (C-horizon). Mass susceptibility, measured at room temperature, shows low values in the E horizon and peak values in the Bh and Bs horizons. The ratio of the mass susceptibility measured at 77 K to 293 K indicates that the E horizon has an increase in paramagnetic iron phases, which is supported by the ratio of mass susceptibility to anhysteretic susceptibility. Acquisition of isothermal remanent magnetization suggests that both a high and low coercivity iron oxide phases are present throughout the entire profile. The higher coercivity phase is more predominant in the eluvial zone and the C horizon, whereas the low coercivity phase dominates in the Bh, Bs and top of Bw horizons. Sequential chemical extractions of the soil samples show that the iron in the E-horizon is found in paramagnetic silicate minerals, whereas ferric oxides and hydroxides are common in the Bh and Bs horizons. The magnetic results will be discussed together with soil chemical data and in the light of the pedogenesis of the soil profile. The combined investigation of magnetic properties with soil chemical analysis provides new insight into pedogenic processes and the magnetic mineralogy of soils.

Keywords: podzol, magnetic properties, pedogenesis

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ASI007 **Oral Presentation** **3123**

Mineral magnetic properties and soil chemistry of Planosols from south Bulgaria

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The most distinctive characteristic of Planosols is their extreme textural differentiation, resulting from intensive podzolization. Iron speciation, mobility and transformation along the depth of soil profiles are governed by the pedogenic processes, thus making it one of the most informative soil characteristics. A mineral magnetic study was carried out for three profiles of Planosols, which exhibit different degrees of podzolization, depending on their topographic position, mean annual precipitation and parent material. Variations in magnetic parameters along the depth of the profiles reflect the elluviation process in the uppermost humic horizon, and subsequent migration and precipitation of Al and Fe in the B-horizons. High-field susceptibility, Xhf, determined from the slope of magnetic hysteresis curves, shows significantly lower values in the albic E-horizons. A sharp increase of Xhf in B-horizons indicates an increase in the amount of paramagnetic minerals (e.g. clay). Low-field magnetic susceptibility discriminates easily the different genetic horizons, with minima associated with the elluvial and B-horizons and maxima with the top parts of the C-horizons of soils, which have developed on granite parent rock. Planosol that developed on schist displays weak variations with significant magnetic enhancement only in the uppermost A horizon, probably due to remaining coarse grains from the parent rock. The deeper Btg horizons, showing signs of gleying exhibit lower X-values. Determinations of total, oxalate-extractable and dithionite-extractable iron are used to estimate the relative proportion of pedogenic, fine-grained maghemites/magnetites, as well as, the amorphous Fe-containing phases.

Keywords: planosols, magnetism

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ASI007 **Oral Presentation** **3124**

Development of soil differentiation in Chernozem - Luvisol Phaeozem genetic types revealed by their rock magnetic and chemical properties

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The development of progressively more differentiated soil profiles as a function of depth is reflected by the content and speciation of Fe-oxides, as well as, their concentration and grain size. In order to study the evolution of magnetic signature determined only by the intrinsic soil processes, several Bulgarian soils that developed on loess as a parent material were investigated. These include aCalcareous Chernozem, Haplic Chernozem, Luvic Chernozem and Luvic Phaeozem. Magnetic susceptibility variations along the depth of the studied profiles mirror the degree of soil differentiation. Elluviation in the upper levels of Haplic and Luvic Chernozems and the Phaeozem is clearly reflected by lower susceptibility. Maximum magnetic enhancement is observed in the upper levels of the structural B-horizons. Hysteresis measurements were used to characterize magnetic grain size variations which show a trend compatible with soil differentiation. Carbonaceous Chernozem and Haplic Chernozem are characterized by the absence of any variations in the composition or grain size of the ferromagnetic mineralogy with depth. The formation of luvic horizons in Luvic Chernozem and Luvic Phaeozem leads to increased magnetic stability in A-horizons, while in B horizons coercivities are lower. X-ray fluorescence (XRF) analysis was carried out on selected levels from each horizon and the concentration of Fe, Al, Si, Mn, Ca, Ti and other elements were determined. Fe and Al translocation, typical for Luvic soils is readily seen. Oxalate- and dithionite-extractible Fe was also determined in order to evaluate the relative contribution of amorphous and crystalline forms of iron.

Keywords: soil differentiation, magnetism

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ASI007 **Oral Presentation** **3125**

Chemical, morphological, and hysteresis characterization of magnetic airborne particulate matter in Rome (Italy)

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The study of the magnetic properties of tree leaves in the town of Rome (Italy) has proved to be a reliable tool to delineate the distribution and the dispersal patterns of anthropogenic airborne particulate matter (PM). Former studies, in fact, demonstrated that the main source of magnetic PM in Rome is represented by circulating vehicles and that the highest concentration of magnetic PM is found along high-traffic roads. Though the magnetic PM particles were characterized in the detail by means of rock magnetism methods, which pointed out the prevalence of low-coercivity magnetite-like particles, their precise composition, morphology and size, as well as their exact source in cars have not yet been identified. For the present study, we carried out a coupled analysis of electron microscopy observations and chemical determinations and of hysteresis measurements on selected PM specimens, with the aim to identify their composition and to unravel the different populations contributing to the overall magnetic PM assemblage. We selected different specimens collected from (1) leaves of Quercus ilex growing along a high-traffic road, (2) filters from an automatic air sampler station in the centre of Rome and (3) powders from different parts of motor vehicles (exhaust, brakes, motor). We characterize individual particles by using an EDS-equipped, Field Emission Scanning Electron Microscope. This instrument allows the low-voltage operations required by organic samples as well as high resolution imaging and quantitative chemical analysis. Moreover, backscattered electron images promptly show metallic vs. non-metallic particles, also uncovering particles buried in the leaf wax. Most particles are 5-0.1 microns in size, and irregular spheres with moss-like surface is the most common morphology. Metallic particles coming from the three car-derived sources that we investigate (i.e., disk brakes, diesel exhaust and petrol exhaust) show different chemical signatures, and variation diagrams allow us to estimate the contribution of each source to the leaves. The data show that the overall magnetic PM in the urban environment is composed by a mixture of particles resulting both from natural and various anthropogenic sources, all of which is characterized by a different chemical and magnetic signature. Different populations of magnetic grains are produced by different parts of motor vehicles. The method appears therefore effective in the discrimination of the origin of PM populations and provides an original tool to monitor PM air pollution.

Keywords: scanning electron microscope, magnetic hysteresis, particulate matter

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ASI007 **Oral Presentation** **3126**

Tracking pleistocene environmental changes in continental archives: the magnetic record of the Pianico-Sellere lacustrine sequence (Northern Italy)

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Climatic and environmental changes, which occurred during the last two millions years in the complex Alpine settings in Northern Italy, led to the formation of several intra-valley basins, where sediments accumulated. Continuous lacustrine sedimentary successions often developed within these basins, therefore providing high-resolution records of continental climatic variability. Oxygen isotopes recorded in benthic foraminifera over the last 3 million years show more than 100 glacial/interglacial cycles. The most important ice volumes of the last ~0.9 million years have been produced during the marine isotopic stage (MIS) 22, 16, 12 6 and 2. Up to date, however, few data exist for continental Early-Middle Pleistocene environments (~0.9-0.7 My). This is partly due to the lack of reliable dating for sections for which methods like 40Ar/39Ar, K/Ar, 14C, or thermoluminescence cannot be applied. More data are needed for better assessing the Pleistocene glaciations in the Alps. Magnetic minerals are produced, transported, accumulated and modified within surface environment and it is well established that the magnetic content of sediments provide a sensitive medium for recording environmental changes. A magneto-mineralogical investigation of the Pleistocene lacustrine succession from Pinico-Sllere in Northern Italy, which covers an interglacial-glacial interval, revealed a general relationship between the magnetic parameters and the pollen and sediment records. A combination of magnetic parameters was used to interpret environmental conditions at the time of deposition of the lacustrine sediments. The high concentration of diamagnetic minerals combined with a weak signal made the interpretation particularly complex. The diamagnetic phases consist mainly of calcite, dolomite, quartz and clay minerals. The larger ferromagnetic particles (> 30 nm) were found to be mainly consisting of low-coercive minerals (i.e. magnetite, maghemite or greigite), whereas high-coercivity phases (i.e. goethite or hematite) often had grain sizes in the superparamagnetic range. The low-coercive phases displayed a uniform grain size distribution. The magnetic parameters within the investigated section were shown to reflect large-scale variations as well as short scale events. Variations could be correlated with changes in climate, detrital supply, sedimentary regimes or other short-term events.

Keywords: pleistocene, magnetic properties, continental archive

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ASI007 **Oral Presentation** **3127**

Enviromagnetics: past, present, and future

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The ubiquitous occurrence of iron oxide particles in the lithosphere, pedosphere, hydrosphere, atmosphere, and biosphere has led to the widespread use of magnetic measurements for tracking environmental change. First-generation studies have firmly established the application of enviromagnetics to such diverse topics as past global change, pollution monitoring, and archaeological site investigations. An accelerating publication output indicates that the field is still growing, partly because of a wider application of well-established methods, but also because of increased emphasis on understanding the basic concepts that underpin the subject. Examples of the former are the increased use of natural biomonitors to assess urban pollution, the finger-printing of the source(s) of sediments in depositional basins, and the persistent observation of non-Milankovich cyclicities in palaeoclimatic proxy records. Examples of the latter include sophisticated "unmixing" procedures to separate (and identify) the multi-component input that comprise most natural environments, attempts to properly take into account the chemical environment (particularly the redox conditions) in soils and sediments, and the innovative use of ferromagnetic resonance spectroscopy to probe magnetofossil structure. Much has been achieved, but more often than not, enviromagnetic records have hitherto been interpreted qualitatively. For the future, improved quantification remains the (elusive?) goal. Can palaeoclimate really be quantified? Can the mass flux involved in atmospheric and oceanic circulation be magnetically assessed? Can mineral pathways in pedogenesis be successfully measured?

Keywords: magnetism, environment

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ASI007 **Oral Presentation** **3128**

Magnetic properties of cave sediments (Southern Carpathians)

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In this study we report the results obtained from a cave situated in the western part of the Southern Carpathians. The cave is famous by the discovery of the oldest modern human of the European continent (c.a. 35000 years BP) and a rich deposit of cave bear bones. U-series ages of stalagmites show a long evolution of the cave with We have sampled an 11 m long section in the cave sediments. The section is composed mainly by clay, silt and two layers with coarser sediments. Two 230Th dates performed by alpha-spectrometry on a stalagmite constrain the upper age of the sediment at around 16 ka. The age of middle part of the section is poor constrained by the presence of bear bones with ESR ages between 136 and 93 ka. We measured both sedimentologic parameters (calcimetry, organic matter, and grain-size distribution) and magnetic parameters (field and frequency dependence of magnetic susceptibility, low and high temperature dependence of magnetic susceptibility, anhysteretic and isothermal remanent magnetization). Magnetic mineralogy is dominated by high coercivity minerals (oxyhydroxides and pyrrothite) and variable content of low coercivity minerals (magnetite). The section is characterized by three peeks of concentration dependent parameters when fine magnetite grains become more important. Following the interpretation of magnetic susceptibility variations in cave sediments of Ellwood et al. (2001), we interpret these peeks as three warm periods when the magnetic signal is enhanced due to magnetically enriched soil washed, and entrapped inside the cave. Some of the high coercivity minerals reflect probably the erosion of the source area dominated by the Paleozoic rocks cropping out north of the cave. From all studied parameters the best proxy for climatic oscillations seems to be the variation of rockmagnetic parameters produced by the enhanced input of pedogenetic magnetite.

Keywords: rockmagnetism, sediments, cave

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ASI007 **Oral Presentation** **3129**

Atmospheric pollution in Beijing area, China: evidences from tree leaf and soil magnetic signatures

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The magnetic method as a fast and cost-effective screening and monitoring technology has been successfully applied in environmental pollution research during recent years. However, most case studies were only related to one environmental target, hydrosphere, atmosphere or pedosphere. The environment of Beijing area is controlled by the regional geological, topographical, hydrological and climatic situation and is heavily influenced by major industrial and agricultural activities, traffic and other factors related to urbanization. The basin-like morphology and prevailing NW winds from the Mongolian deserts, causing regular sandstorms, intensify the extremely high degree of atmospheric pollution in Beijing. In order to investigate the environmental situation in such a complex metropolis, an approach had to be developed and applied which combines screening/monitoring of atmospheric dust and its fallout and accumulation in pedosphere and biosphere, respectively. Important targets are the relationship between magnetic parameters and toxic materials and the separation of the different environmental responses to various human activities. For this purpose, tree leaves and soils were selected in a combined way as targets of this study in Beijing. More than 650 tree leave samples (cypress and others) were taken in the years 2004-2006, at 223 sites magnetic measurements on top soils were conducted and 68 cores (20-50 cm deep) were sampled and soil profiles measured on site in Beijing urban and suburban area. The high resolution results revealed big regional differences of the magnetic susceptibility (MS) distribution not only on the soil surface but also in different depth within the profiles. MS was found to be highest in the western Beijing industrial area soils (steel mill, coal-fired power plants) whereby lower MS topsoil values dominate the city center and the eastern countryside. Soil MS from different depths in the western industrial area exhibits the highest values of 400-100010-5 SI in the upper 5 cm layer. There is a gradual decrease to 250-30010-5 SI at 15-20 cm depth, followed by background values (geology) of 150-20010-5 SI below 20 cm. The values from the city center and eastern countryside are much lower (around 150-20010-5 SI in the upper 5 cm layer), and relatively stable along the profile. The MS distribution patterns of the tree leafs within Beijing greater area coincide surprisingly well with the topsoil MS pattern. Close correlation of leaf magnetic properties (MS, SIRM) and the content of certain pollutants such as Fe shows that the nondestructive, time-efficient environmental magnetism of tree leafs serves as an excellent proxy for the state of the environment of major urban areas. Additionally, more detailed magnetic and geochemical analyses were carried out on three selected soil profiles from the steel mill area, the airport highway and a site with dumped soil. Summarizing, tree leafs as dust trap in urban areas have the significant advantage that the uncontrollable soil conditions and history can be avoided, the geological background signal can be neglected and short term pollution records can be obtained (days to years) depending on the specific requirements. The project will be continued to monitor the expected improvement of the Beijing air quality due to the Steel mill moving out and other respective actions in the forefield and after the 2008 Olympic games.Acknowledgment This work is supported by the funds from the National Natural Science Foundation of China to HS (40674033, 40374021), and by the Deutsche Forschungsgemeinschaft (grants AP 34/21-1 to EA, 446 CHV 111/7/06 and others to VH).

Keywords: beijing china, air pollution, magnetic proxies

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ASI007 **Poster presentation** **3130**

The magnetic signature of present environmental changes in lake sediments induced by hydrotechnical works; a case study from the Danube Delta (Romania)

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The case study is dealing with the environmental changes detected by magnetic susceptibility (MS) measurements carried out on the lake sediments sampled in the Mesteru Fortuna Depression (Danube Delta/DD) during 1980 2006. The MS signatures identified in the bottom sediments before and after a short canal was dug up between two DD Branches have undergone obvious modifications, showing the impact of the anthropogenic pressure on the sedimentary processes. After cutting the Mila 36 Canal in this area, in 1982-1983, the dynamics of the water and sediments within the western part of the depression was strongly influenced by the very significant liquid and solid riverine supplies. The sedimentary environments from three main lakes (i.e. Lungu, Mesteru and Tataru) were investigated in 1980, but also in 1987, 1992 1997 and 2006. The first two lakes mentioned underwent an intensive process of filling up with sediments, the Lungu L. being most exposed to the direct fluvial influx. The Tataru L. has not undergone important changes after the severe modification of the hydrological conditions in the area; its spatial position (relating to the Lungu L. and the Draghilea Chn.) made possible a double protection against the direct Danubian supplies. An original Magnetic Susceptibility Scale (k Scale), with 5 classes (IV) and 4 sub-classes (Va, Vb, Vc, Vd), was used to calibrate the lake sediments and to evaluate the enviromagnetic fingerprints. The MS Scale, originating in the DD lake sediments and having a genuine lithological support, spans between k values lower than 10x10E-06 SIu. and k values higher than 1000x10E-06 SIu. The MS signature identified in the sediments sampled in the Lungu and Mesteru Lakes in 1980 was mainly characterised by k classes II and III. After the Mila 36 Canal was dug up in the area, the lake sediments were calibrated to higher k classes (IV, Va, and even Vb) for the Lungu L. (closer to the Mila 36 C. inflow mouth), and to the intermediate (III) and high classes (IV and Va) for the Mesteru L. The enviromagnetic fingerprint detected in the Tataru Lake sediments in 1980, 1993-1997 and 2006 keeps the same intensity, calibrated to k class III. In the case of a lake protected from the direct Danubian sedimentary influx, the k classes I and II correlate to the high and good quality categories of the Scale with the normative definitions of the ecological status classification (Ecological Quality Scale/EQS); when the lake is under anthropogenic pressure, the k class III corresponds to the moderate quality, and the k classes IV and V to the poor and bad qualities shown by the EQS. The results presented in the paper emphasize the good correlation of the MS and EQ Scales.

Keywords: environmental magnetism, lake sediment, anthropogenic pressure

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ASI007 **Poster presentation** **3131**

A detailed map of anthropogenic pollution in Giant Mountains National Park by using soil magnetometry

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Topsoil layers act as sink of atmospherically deposited dust, which usually comprises, among others, significant portion (5 10 wt%) of ferrimagnetic Fe-oxides. Low-field magnetic susceptibility represents one of the major magnetic parameters, indicating concentration of ferrimagnetic particles in soils. Therefore, relative simple and fast in situ mapping of topsoil magnetic susceptibility can be used as a proxy to determine the spatial distribution of particles linked to environmental pollution. In our contribution, application of soil magnetometry is demonstrated on regional scale of the Giant Mountains National Park , which covers an area of about 425 km2. Measurements of vertical susceptibility distribution over the whole area confirm that lithologic contribution does not affect significantly the surface measurements of magnetic susceptibility. At the same time, on the basis of laboratory measurements, it was verified that anthropogenic ferrimagnetic particles are unambiguously the reason of increased values of magnetic susceptibility of topsoils in the investigated region. In situ measurements of topsoil magnetic susceptibility were performed using portable MS2D Bartington loop sensor. Large data set (obtained from more than 450 localities) was used to compile a 2-D map, which represents distribution of atmospheric dust deposition in the studied region and outlines areas of increased soil contamination, resulting from local pollution sources. Our basic map can be used for monitoring the temporal development of pollution in the investigated region. This study was supported by Grant Agency ASCR through grant No. A3012905 and Grant Agency of the Czech Republic through grant No.205/07/0941.

Keywords: anthropogenic pollution, soil magnetometry, mapping

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ASI007 **Poster presentation** **3132**

Correlation between particle size distribution and rock-magnetic parameters of the marine sediments from off Wilkesland, East Antarctica

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Marine sediment cores from off Wilkesland, East Antarctica (60-75deg.S , 110-180deg.E) dated Late Pleistocene to the Brunhes-Matuyama boundary, the length of which were 3-7m, were studied using particle size distribution and rock-magnetic parameters. The particle size distribution was measured using a laser diffraction particle size analyzer Hydro2000s. Hysteresis parameters (Hcr: coercivity of remanence, Hc: coercivity, Mr: isothermal remanent magnetization, Ms: saturation magnetization), isothermal remanent magnetizations (IRMs of magnetic field of 1T, and back magnetic field of 0.1T and of 0.3T), and magnetic susceptibility were measured as rock magnetic parameters. S-ratio (IRM of 1T / IRM of back magnetic field of 0.1T), Hcr/Hc, Mr/Ms and SIRM/k vary cyclically 4~5 times from the surface of the cores to the B-M boundary. In comparison of variation of magnetic parameters with particle size distribution, clear correlation was found between particle size and both SIRM/k and s-ratio. While SIRM/k increased as the increase of the amount of particles of 1-10 micrometer, S-ratio decreased. High temperature analyses of saturation magnetization (Ms-T) show that the magnetic carrier is maghemite, and clear Verwey transition in low temperature analyses show the existence of magnetite. These iron oxides will suggest the oxidized condition of the sea bottom after B-M boundary. The sediments of these cores include ice rafting debris (IRD), mainly of clay size particles with a trifle of coarse particles. Ice-sheet development history and climate change would be discussed from the particle size variations

Keywords: antarctica, particle size distribution, rock magnetic parameter

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ASI007 **Poster presentation** **3133**

Environmental magnetism of the terrestrial moss Hylocomium splendens: Results from a south-north profile crossing the city of Oslo, Norway

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Terrestrial mosses are commonly used to map and monitor airborne heavy metal contamination via geochemical analysis of element concentrations in air-dried moss samples. While this method results in quantitative net values of the elemental composition,it cannot distinguish whether elements are bound in organic or inorganic compounds,or trace further details of their source(s). Here we present results from magnetic measurements on forty terrestrial moss (Hylocomium splendens), and corresponding soil samples, which were collected along a 120 km long south - north transect running through Norways largest city, Oslo. Magnetic measurements are very specific, in that they focus on iron minerals.They allow for a more detailed interpretation in terms of intrinsic propertiesof these minerals. To show this, we measured magnetic susceptibility as a net value comprising concentrations of dia-, (anti)ferro-, ferri-, and paramagnetic minerals. In addition, we determined the isothermal magnetic remanence (IRM) after applying a 700 mT external field, and its alternating field (AF) demagnetization curve. Both concentration-dependent measurements, magnetic susceptibility, and IRM(700 mT),closely resemble the elemental Fe distribution and display a clear peak in the urban environment. Surprisingly, also the concentration-independent ratio IRM25/IRM60 - where IRMx denotes the x mT AF demagnetization step of the IRM - displays higher values in the urban environment. This indicates that: 1) the iron signal from Hylocomium splendens is mostly related to remanence-bearing minerals and less to organic iron compounds; 2) the magnetic properties of these minerals change between urban and remote environments. Together these observations strongly support the assumption that the iron signal in mosses is due to adsorbed dust, which then will also contribute to other elemental signals. Magnetic measurements thus help to separate antropogenic from geogenic signals in geochemical analyses of moss samples.

Keywords: moss, enviromental magnetism

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ASI007 **Poster presentation** **3134**

Topsoils magnetic susceptibility mapping – as a tool for pollution monitoring by heavy metals in the vicinity of nickel factory dump in the slovak city of SereĎ

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Many recent studies applied magnetic susceptibility mapping as a tool for preliminary pollution monitoring and as a rapid and inexpensive (proxy) methods of outlining areas exposed to increased pollution by atmospherc particulates of industrial origin. This method is based on the knowledge, that in topsoils, heavy metals are predominantly fixed on/in ferro- and ferrimagnetic minerals. It seems that this coexistence plays the msot important role, although magnetic particles can serve also as carriers of the heavy metals, either adsorbed on their surface, or incorporated into their structure. Therefore, measurement of the magnetic susceptibility can be employed as a simple and rapid screening method to asses the level of soil pollution. This approach was successfully applied in several European cities, and can be used in all situations, where it is reasonable to assume that magnetic particles and pollutants (mainly metals) coexist. We tested the applicability of magnetic susceptibility measurement for the detection of industrial soil pollution in the surroundings of a large dump from the (by now closed) nickel factory in the city of Sereď, situated in the south-western region of Slovakia. The environmental load here represents approximately 5.5 mill. tons of material with nickel as the most important pollutant. The study locality was a 6 x 6 km square area situated mainly in the southern and southeastern direction from the dump (including the dump itself). Altogether 183 soil samples were taken from three horizons (20 cm, 40 cm and 60 cm, respectively), air-dried and measured for the mass susceptibility on the KLY-2 kappabridge. The results show that the topsoils in the studied area are characterized by enhanced magnetic susceptibility κ, with highest values, as expected, directly in the dump. In general, κ decreases with increasing distance from the dump, as well as with increasing depth from the surface. Previously, the geochemical mapping of this area was carried out by Čurlk and. Šefčk (1997). Their results make it possible to correlate the magnetic susceptibility values with the concentration of heavy metals, particularly that of nickel. This results comparison revealed the high positive correlation. Therefore the measurement of magnetic susceptibility of soils can be - in this case - used as a supplemental method to the geochemical mapping method, which allows to assess, in a simple, cheap and rapid way, the level of soil pollution in sites, where the geochemical data are missing. References Čurlk J, Šefčk P.,1997, Geochemical Atlas of Slovak Republic - Part Soils, Slovak Geol.Magazine, vol.3, 1, 37-51

Keywords: magnetic susceptibility, heavy metals, pollutions

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ASI008 **3135 - 3141**

Symposium
Magnetism of extraterrestrial materials and bodies

Convener : Mr. Tomas Kohout

The session is focused on the magnetic signature and properties of extraterrestrial materials and bodies ranging in size from meteorites and asteroids to moons and planets. The aim is to present and discuss new approaches and results in the research of rock magnetic properties of extraterrestrial matter, impact cratering process and its magnetic signature, the implications to ancient magnetic dynamos and paleofields. the session is open to all laboratory, theoretical and remote sensing studies.

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ASI008 **Oral Presentation** **3135**

Vesta's possible magnetic field: comparison between plasma simulations and optical data

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Recently, Vernazza et al. (2006) suggested that Vesta, the second-largest asteroid known in our Solar System, must have a magnetic field at its surface which diverts the solar wind ions, thus explaining its pristine surface. However, their data does not allow distinguishing between 1) a global magnetic field producing a bona fide magnetosphere and 2) a number of blocks of crustal material uniformly magnetized producing several crustal magnetospheres. In the first case, the ions would reach the surface via the magnetic poles and significantly darken the surface there. In the second case, the solar wind particles would reach the surface via a number of cusps and imply the presence of several optically dark regions. Indeed, images obtained by the Hubble Space Telescope (HST) in 1994 showed that Vesta possesses regions of differing spectral albedos (Zellner et al., 1997; Binzel et al., 1997). More recent observations with the Keck II Telescope (Zellner et al., 2005) confirm the presence of dark and bright areas. Actually, two scenarios can explain the presence of dark and bright regions: 1) a variation in the surface composition as it exists on the Moon (bright highlands-dark mares). 2) a magnetization producing the presence of solar wind protected/unprotected areas. Both scenarios have already been observed on the Moon with the presence of respectively (1) bright highlands-dark mares of different composition, and (2) bright (solar wind protected) areas (swirls) observed within dark (solar wind unprotected) lunar mares. Here, we present new results obtained with a three-dimensional hybrid code simulating the interaction of the solar wind with Vesta, assuming one or several (randomly placed) magnetic dipoles, and compare them with the HST images. To facilitate the comparison, the output of the simulation is a map of Vestas surface (longitude, latitude) showing with a color coded third dimension the flux of solar wind ions reaching the asteroid surface, that we code in color from white to black, since those ions produce progressive darkening of the surface.

Keywords: asteroid vesta, plasma simulations, magnetic field

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ASI008 **Oral Presentation** **3136**

Lunar Magnetism: IRMs Normalization and Impact Related Magnetization.

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Models of lunar magnetism need to explain: (1) strong Natural Remanent Magnetization (NRM), indicated by IRMs normalization, in some of the returned Apollo Mare Basalts and Melt Rocks with ages from about 3.85Ae to 3.65 Ae, (2) magnetic anomalies antipodal to the young basins of a similar age, (3) the absence of major magnetic anomalies over these same basins and the presence of minor anomalies over uplifted basement. (4) strong fields with scale lengths of homogeneity of the order of kms, or less, are found over the Cayley Formations and similar material. Observation (1) has frequently been taken to require the presence of a lunar dynamo. However, this presents a dilemma. If there were a lunar dynamo at that time, why were the basin melt sheets not magnetized in the field of the dynamo. It is also an uncomfortable coincidence that the dynamo is only extant close to the time of the late heavy bombardment. Given these difficulties and questions of the efficiency of dynamo action in a lunar core, it is worth reexamining other possible explanations of lunar magnetism. Hoods model accounts for the antipodal anomalies, while the observations at Vredefort (Carpozen, et al., 2003) may account for the anomalies over central peaks and uplifted ring structures in major basins. Experimental work by Crawford and Schultz (1999) has demonstrated that impacts of projectiles traveling at kms/sec generate magnetic fields. Srnka et al, (1979) showed that magnetic fields can be recorded by shock with demagnetization characteristics similar to thermal remanent magnetization. The question that remains is whether all of the observed lunar magnetization can be explained by impact related magnetization directly and indirectly through magnetization acquired in the remanent fields of material magnetized by impacts.

Keywords: moon, impacts, paleointensity

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ASI008 **Oral Presentation** **3137**

Magnetic properties of micrometeorites

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Micrometeorites are terrestrially collected extraterrestrial particles smaller than about one millimeter. They constitute the main part of the mass flux of extraterrestrial material accreted on Earth. Most of them melt during atmospheric entry and are called cosmic spherules. In this study, we performed measurements on more than 400 cosmic spherules and a few unmelted micrometeorites from Antarctic aeolian sedimentary traps, Antarctic blue ice fields and snow, and Pacific deep-sea sediments. Chemical and textural analyses confirmed the extraterrestrial origin of the samples. Natural remanent magnetization (NRM) and isothermal remanent magnetization (IRM) were measured, followed by alternating field or thermal stepwise demagnetization. Hysteresis parameters, magnetic susceptibility and anisotropy of magnetic susceptibility were also measured. Magnetite is the main magnetic mineral in cosmic spherules and micrometeorites, and most samples have pseudo-single-domain magnetite grains. The mean values for hysteresis parameters are Hcr = 30 mT and Mrs/Ms = 0.38. The samples usually show a large coercivity and are thus able to carry a strong stable NRM. The NRM/IRM ratio is consistent with a thermal remanent magnetization (TRM) acquired during the cooling in the atmosphere. The anisotropy of magnetic susceptibility is very strong and shows planar fabrics that could be related with the barred olivine texture. Hysteresis parameters give a non-destructive proxy for the classification of Iron type and Stony type spherules.

Keywords: micrometeorites, magnetic properties

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ASI008 **Oral Presentation** **3138**

Low-temperature magnetic properties of the Neuschwanstein EL6 meteorite

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The low-temperature magnetic properties of the Neuschwanstein EL6 meteorite as well as of the daubreelite ($FeCr_2S_4$), troilite (FeS), and FeNi mineral phases were investigated. Low-temperature magnetic behavior of the Neuschwanstein meteorite appears to be controlled mostly by FeNi. However, two magnetic features at ~ 70 K (Tm) and 150 K (Tc), apparently due to a magnetic transition and Curie temperature of ferrimagnetic daubreelite, respectively, have also been identified. The ~ 10 K temperature difference between the Neuschwanstein anomalies and Tm or Tc of daubreelite from the Coahuila meteorite and synthetic $FeCr_2S_4$ is most likely due to a slightly different Fe/Cr stoichiometric ratio, or to presence of impurities and / or due to crystalline lattice defects. In the antiferromagnetic troilite a magnetic transition at Tm ~60 K was identified. Its nature seems to be most likely due to a change in the orientation and attendant canting of the antiparallel spins. However, this feature was not identified in the Neuschwanstein meteorite measurements because of low concentration and low magnetization of the phase compared to that of FeNi and daubreelite. Daubreelite with its Tc ~160 K might be a significant magnetic mineral in cold environment. Low-temperature magnetic data of daubreelite, troilite and FeNi presented here can be useful for the interpretation of the low-temperature magnetic measurements of various extraterrestrial materials and to identify the presence of these phases.

Keywords: neuschwanstein meteorite, daubreelite, troilite

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ASI008 **Oral Presentation** **3139**

Magnetic signature of the Bosumtwi impact structure, Ghana comparison of laboratory studies of ICDP DRILL cores and surface samples

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The interpretation of rock magnetic and paleomagnetic data sets is essential to understand the formation mechanism and magnetic signature of the relatively young (1.07Ma) and small (D=10.5km) Bosumtwi impact structure in Ghana. Data from two hard rock drill cores within the impact structure, obtained by the Bosumtwi Crater Drilling Project, and exposed surface samples near the inner rim, are presented. Results of core samples consisting of impactites as well as target rocks show weak magnetic susceptibility (200500E-6SI) and natural remanent magnetization (0.1mA/m-100mA/m) with Q values mostly over 1, indicating that remanence dominates over induced magnetization. Only a very small, inhomogeneously distributed ferrimagnetic component with higher susceptibility and remanence values is present within target lithologies. In all lithologies rock magnetic properties are carried by pyrrhotite. Although minor traces of titanomagnetites were observed as well in thermal treatment, the differences of hysteresis parameters before and after heating, point to the possibility that magnetite was formed mainly during the thermal treatment of the rocks. The surface samples indicate also relatively low magnetic susceptibility and remanence; however the main difference is that titanomagnetite (not pyrrhotite) appears to be main carrier of the magnetization in those samples. To get further light into the problems we have collected new samples from previously unstudied areas of southern rim. With new data we will focus to understand the differences existing in core and surface samples. We hope the results will provide new input data for modeling and interpreting the aeromagnetic anomaly patterns.

Keywords: magnetism, bosumtwi

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ASI008 **Oral Presentation** **3140**

Magnetic signature of SNC meteorites: new perspectives for martian magnetism

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Exploring the magnetic signature of the Martian meteorites (SNC) as the only available samples from the red planet will help to clarify the potential existence and history of a strong magnetic dipole field on Mars. The presence of an active magnetic dynamo is generally accepted as a major precondition for the development of a stable, dense atmosphere and the presence of liquid water both representing the frame for the development of prebiotic structures or primitive life on Mars. Our knowledge concerning the magnetic history of Mars, the physical/mineralogical background of the strong crustal magnetic anomalies as well as the missing magnetic anomalies at large impact sites is quite poor. Presently 34 from the known 42 unpaired SNC meteorites are included in our systematic search of the magnetic record. For the first time detailed magnetic studies are performed on the NIPR specimen, as they are the lherzolitic shergottites ALH 77005, Ym 793605 and the new Ym 0000027/047/97 (probably paired), Ym 980459 (olivine-phyric shergottite) and Ym 000593/802/749 (paired nakhlites). Also most recent hot desert findings such as NWA 4480/4468/4527 (basalts), NWA 1950/2646 (lherzolites) and NWA 2737 (shocked dunite) are included in our project. Exceptions are the 2 GRV lherzolitic shergottites (99027 and 020090) which are curated in the Chinese Antarctic Meteorite Collection and Ya 1075 of which the situation is not really clear. For the first time frequency/field dependence of magnetic susceptibility (k) using SM100 instrumentation and low temperature IRM investigations using MPMS from 0.5K to RT are included and performed on all SNC. Measuring frequency (in five steps) and field dependence (in six steps) of k are proposed as new routine characterising tools for stony meteorites as it can be easily performed in collections or in field using SM100. The magnetic microstructure is observed on selected samples using Bitter-technique and Magnetic Force Microscope (MFM) in order to visualize the magnetisation structures and processes as well as the influence of shock metamorphism (for example the shock induced neo-formation of Fe-Fe/Ni nano-particles) on the magnetic record in detail. For Ym 000593/802/749 k was found to be slightly higher than for most of the other nakhlites. A clear trend of decreasing k values from the largest nakhlite, Ym593 (13.5kg), to the smallest nakhlite, Ym802 (22gr) is evident which most likely reflects terrestrial weathering effects. A new more quantitative test of the influence of terrestrial weathering and its discrimination from Martian weathering effects is proposed based on the magnetic signature. Generally, the magnetic signature is quite variable for the lherzolitic shergottites, sometimes even within one and the same specimen which contrasts with the more homogeneous distribution of the magnetic data of the other shergottite groups and the nakhlites. The lowest k values were obtained for the lherzolites Ym 793605/000097 in the range of NWA 1950/2646 while ALH 77005 showed much higher values and large scatters of k . The anisotropy of k, here the P factor, is in the range of 1,01-1,15 which is typical for volcanic or shallow subsurface intrusive rocks. Low temperature experiments (MPMS) revealed the presence of magnetite and Ti-, Al-, Mg-substitutes as well as ferri-chromite in some cases. For the first time, clear evidence was obtained (detection of the 34K transition) for monoclinic pyrrhotite (Fe7S8) being a dominating magnetic phase in some shergottites [3,4]. Surprisingly, monoclinic pyrrhotite (Fe7S8) was also found in the Ym000593/749 nakhlites by magnetic/micromagnetic means but not in Ym000802 [6]. Our findings might support the impact demagnetization model based on the 2.8 GPa high-pressure transition of monoclinic pyrrhotite which was proposed by [5]. However, similar magnetic experiments (material magnetism) are urgently needed on future Mars missions to test our models under more realistic conditions and to fill the present

gaps between Mars meteorite and in-situ data (e. g. the haematite problem).References: [1] Rochette P., Gattacceca J., Chevrier V., Hoffmann V., Lorand J.P., Funaki M., Hochleitner R.: Meteor. Planet. Sci., 40/2005, 529-540. [2] Rochette P., Gattacceca J., Chevrier V., Hoffmann V., Lorand J.P., Funaki M., Hochleitner R.: LPSC XXXVI/1614, 2005. [3] Hoffmann V., Funaki M.: Ant. Meteor., 30 (2006), 22-23. [4] Funaki M., Hoffmann V., Torii M.: Trav. Geophys., 27/2006, 51. [5] Rochette P., Fillion G., Ballou R., Brunet F., Ouladdiaf B., Hood L.: Geophys. Res. Lett., 30/2003, 16 1-4. [6] Funaki M., Hoffmann V, Torii M.. Abstract AGU2007/Acapulco.Acknowledgements: The project is funded by DFG (VH) within the prority programme "Mars and the terrestrial planets" SPP1115. Sample supply by NIPR, NASA, several museums and many private collectors is highly acknowledged.

Keywords: martian meteorites, snc, magnetism

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ASI008 **Oral Presentation** **3141**

The effects of shock on low-coercivity magnetization in pyrrhotite in the Martian crust and meteorites

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Most meteorites and planetary surfaces have been subject to shock compression from collisions and impact cratering events. We performed analogous shock recovery experiments on natural pyrrhotite, a magnetic carrier in Martian meteorites, to study the effects of shock on magnetic properties. Peak pressures up to ~7 GPa and μs duration were generated using the 40 mm gas gun at Harvard, and the effects of dynamic pressure on rock magnetic properties were measured using superconducting rock magnetometers at Caltech and MIT. Up to 90% of high-field isothermal remanent magnetization (IRMHF) in the samples was removed. However, the amount of demagnetization was not monotonic with peak pressure, unlike that observed in static experiments. The initial coercivity distribution of the samples is an important factor in shock demagnetization. The low-coercivity fraction between 0 and 20 mT, which initially dominated the IRMHF, was preferentially removed by the shock wave. After the shock, IRMHF was dominated by a broader coercivity range, between 0 and 60 mT, and the bulk coercivity increased, indicating that some of the low-coercivity carriers were permanently removed and higher coercivity carriers were gained. Other post-shock permanent changes in magnetic properties include increasing saturation isothermal remanent magnetization, increasing low-temperature memory, and changes in squareness of hysteresis. All of these changes are consistent with an increase in the volume fraction of single domain grains. We find that pyrrhotite-bearing rocks and meteorites may retain records of Martian magnetic fields even if shocked to pressures approaching 7 GPa. Therefore, we conclude that pressure demagnetization of the Martian crust surrounding impact basins is more complex than previously assumed from static experiments. In addition, the application of some paleointensity techniques to shocked meteorites, without accounting for the shock-induced changes in the remanence and magnetic properties, may underestimate the paleofields on Mars and other bodies.

Keywords: pyrrhotite, mars, shock demagnetization

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ASI009 **3142 - 3158**

Symposium
Progress in palaeo- and rock-magnetic methodologies

Convener : Dr. Ramon Egli
Co-Convener : Dr. Eduard Petrovsky

The symposium will address recently developed methods and underlying theories related to paleomagnetism, rock- and environmental magnetism. Key progress in paleomagnetism include microwave demagnetization and paleointensity determination techniques, as well as measurements of single crystals. In the field of rock magnetism, focus is given to various techniques for the characterization of magnetic particle assemblages, such as FORC diagram and other hysteresis properties, low-temperature transitions, various determinations of grain size distributions, and quantitative unmixing methods. Contributions to the theoretical backgrounds of the abovementioned methodologies are welcomed, especially if linked to direct applications. Included are models of magnetic mineral properties that can be used for identification and quantification purposes in rocks and sediments, as well as reports on the statistical properties of populations of magnetic particles

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ASI009 **Oral Presentation** **3142**

First-order Reversal Curve (FORC) Diagrams of Natural and Cultured Biogenic Magnetic Particles

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Dr Ramon Egli, Dr. Bruce M. Moskowitz

First-order reversal curve (FORC) diagrams are rapidly becoming a standard tool for characterizing magnetic particles because they simultaneously incorporate information regarding magnetostatic interaction and domain states. The simplest interpretation of FORC diagrams of single-domain (SD) particles is based on the Neel interpretation of Preisach theory, which predicts that the FORC function is the product of a coercivity and an interaction field distribution. Although the underlying assumptions of this interpretation are not correct, a strictly quantitative model of weakly interacting SD grains proves that the distributions of coercivities and interaction fields can be retrieved from a FORC diagram [Egli, 2006a]. To test this model we present the possibility of a quantitative interpretation of FORC diagrams, we present measurements of samples containing magnetosomes from cultures of magnetotactic bacteria and from a lake sediment. Two samples are investigated under the electron microscope to characterize the geometrical arrangement of the particles. We find that the clustering of otherwise similar particles has a strong influence on FORC diagrams. We also obtained a crude estimate of packing densities form the FORC diagrams, which were consistent with TEM observations and measurements of the anhysteretic remanent magnetization.

Keywords: forc, magnetostatic interaction, magnetosome

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ASI009 **Oral Presentation** **3143**

A new magnetometer system

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A new system for its application in paleomagnetism is presented, based on a small bore 3 axis-SQUID magnetometer that uses a high-efficient crycooler eliminating the necessity of helium refill. The use of 12 mm diameter and 10 mm long samples allows for fast heating and cooling, due to their reduced mass and increased surface to volume ratio compared with 25 mm samples. Heating is done using an ellipsoidal reflector where the sample is positioned in one focal point, being heated by the infrared radiation produced by a high-power bulb positioned in the other focal point. The fast thermal cycling allows for automatic stepwise thermal demagnetization. Apart of the thermal demagnetizing facility, the system could be combined with most other instruments, like AF demagnetizer, pulsmagnetizer for acquisition of IRM, a resonant cavity for application of microwave radiation. Triple Helmholtz field coils would allow to use controlled laboratory fields and thus to carry out paleointensity experiments using the parallel or perpendicular field methods.

Keywords: paleomagnetism, instrumentation

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ASI009 **Oral Presentation** **3144**

Quality control of rock-magnetic measurements of weak samples

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In rock and environmental magnetism, often magnetically weak samples have to be investigated. Weak magnetic signal of the samples may be due to small volume of the samples, their magnetic mineralogy (absence of ferrimagnets), low concentration and specific grain-size distribution. Any of these effects may play role alone, or in combination with the others. In classical paleomagnetism, samples of standard volume(s) are investigated. However, the measured remanent magnetization is often very low due to specific mineralogy and concentration. During the years, measurement processes have been well established based on highly sensitive instruments (spinner and SQUID magnetometers) and measurements are routinely carried out in magnetically shielded space. However, in rock and environmental magnetism, often the samples in concern are of arbitrary volume and shape, with very low concentrations of ferrimagnets. Measurements are mostly based on wide range of parameters, mainly measurements of hysteresis loops. Highly sensitive instruments enable measurements of extremely low concentrations of ferrimagnets. On the other hand, special attention must be paid to quality of the measured data, especially in terms of representativness and repeatability of measurements. Last but not least, background signal from the sample holder (and magnetic substance carrier/matrix) becomes very important and should be treated properly. In our contribution, we will demonstrate measurements of hysteresis loops and IRM acquisition curves of atmospheric PM10 collected over 24 hours on quartz microfibre filters using a vibrating sample magnetometer. Measurement considerations, such as problems of noisy signal, effect of sample positioning, importance of the background signal treatment, will be addressed.

Keywords: rock magnetism, hysteresis, weak

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ASI009 **Oral Presentation** **3145**

MORIN TRANSITION IN HEMATITES

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Saturation isothermal remanent magnetization (SIRM) has been studied on synthetic submicron (SD) hematites with grain sizes between 120 and 520 nm and on 0.5 to 6 mm natural (MD) hematite single crystals before and after zero-field cycling through the Morin transition (Tm). The sharp and well-defined remanence transitions show that all samples are stoichiometric hematite with no significant impurities. Even small amount of cation impurities would broaden the transition. The Morin transition temperature is quite variable. Tm ranged from 250 to 261 K for the natural crystals and even more widely, from 241 to 254 K for the more heterogeneous synthetic hematites. There is not a 1-1 correlation between grain size and Tm for both submicron and bulk hematites. The scattered data must be due to the method of preparation, crystal morphology, strain and crystal imperfections that are common for synthetic and natural crystals. The present Tm data for SD and MD hematites are compatible with the published data by other workers in the 100 nm - 10 mm range. In this interval, Tm decreases slightly with decreasing particle size. It is almost grain-size independent. In nanoparticles with grain sizes between 90 and 30 nm, the spin-flop transition temperature is strongly dependent on particle size, decreases abruptly and disappears below 20 nm. This is due to surface effects that lead to spin directions deviating from the easy axis. Present SD and MD hematites exhibit a thermal hysteresis in the Morin transition, Tm being higher in warming than in cooling. For the same cooling/warming rate, the width of the Morin transition in the submicron crystals is broader than for the natural single crystals. However, this broadening is directly attributable to the wide distribution of particle size. In natural single crystals the entire width of the transition could be due to the inhomogeneities of strain, defects and other crystal imperfections.

Keywords: morintransition, thermalhysteresis, saturationremanence

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ASI009 **Oral Presentation** **3146**

Transition Warming and Cooling Remanences

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One way of gaining insight into the size and morphology of assemblages of magnetite particles is to compare either remanence or susceptibility at low temperatures after zero-field cooling (ZFC) and after field cooling (FC) through the Verwey transition around Tv = 120 K. At 10 K a sample is demagnetized following ZFC, while in the FC initial state before warming the sample has a transition cooling remanence (TCRM), acquired largely but not entirely in crossing Tv. There is also a reciprocal remanence acquired as a result of heating a demagnetized sample from low temperature across Tv. This transition warming remanence (TWRM) is often called an inverse TRM. Hematite and pyrrhotite also acquire TCRM and TWRM in crossing a low-T magnetic phase transition in the presence of a field. In my TCRM experiments, initially demagnetized samples were cooled in a 2 mT field from 300 K to 10 K. Their magnetizations were measured at 1 K to 5 K intervals, the highest resolution data being taken between 140 K and 90 K for the magnetite samples. At 10 K, the field was zeroed, and the remanence was then monitored during zero-field warming back to 300 K. The properties of TCRMs were generally similar to those of TWRMs produced by heating a ZFC sample in a 2 mT field from 10 K, but the increase in induced magnetization for the magnetites and pyrrhotites in cooling through their phase transitions was relatively small because of the very high coercivity of the low-temperature phase of both minerals. In the case of hematite, where the low-temperature phase is almost non-ferromagnetic, the induced magnetization actually decreased across the transition. On the other hand, 70-90% of the induced magnetization was retained as remanence when the field was zeroed at 10 K, and up to 20% of this remanence survived zero-field warming through the transition. For hematite, this room-temperature memory was much larger than the remanence below the Morin transition. A remarkable property is the observed mirror-image symmetry between in-field warming curves tracking the acquisition of TWRM and zero-field warming curves of TCRM between 10 K and 300 K. The symmetry, with increases in the field-on induced + remanent magnetization curves exactly mirroring decreases in the field-off remanent magnetization curves, is almost perfect from 10-110 K. With detailed study of the properties of transition remanences, we hope to understand why the ZFC/FC method is diagnostic in some instances and not in others.

Keywords: magnetic transitions, verwey transition, zfc fc

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ASI009 **Oral Presentation** **3147**

Thermochemical alteration of magnetic minerals - exploiting the undesirable.

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Jozef Hus

Thermochemical alteration during laboratory heating experiments is undesirable for any palaeomagnetist because of its substantial influence on mineral magnetic properties changes, hence rendering the interpretation of results difficult. Instead of rejecting the data we propose to exploit the unwanted thermochemical alterations on the magnetic mineral content for temperature reconstructions in baked clay. The concept is as follows: if a sample had been heated in the past to a temperature T1 it will not change its properties if it is reheated under similar conditions. When the sample is reheated above T1 the minerals are not anymore in thermochemical equilibrium resulting in mineral property changes. The same concept is used in archaeometry, taking advantage of changes in clay mineralogy and structure during progressive laboratory heating. We subsampled a large baked clay block sample from the combustion chamber wall of a Roman pottery kiln at Bruyelle (Belgium), where variable colours suggest that strong thermal gradients were present. Powdered specimens were heated at different temperatures in an oxidising atmosphere. Magnetic low-field susceptibility, backfield curves and short-term viscous remanence decay were examined after each heating step in dependence of the distance to the combustion chamber. Considerable changes at already low heating temperatures were observed close to the combustion chamber due to variable heating conditions in ancient times and in the laboratory. At further distances from the combustion chamber past and present heating conditions are similar and the change of magnetic properties is only caused by temperature differences. The degree of magnetic mineral alteration between two consecutive heating steps was quantitatively assessed by an alteration parameter which can be defined as the normalised root of the squared difference of a certain magnetic parameter between two heating steps. The temperature at which the parameter increases considerably is considered as the maximum ancient baking temperature that was reached. Maximum ancient heating temperatures of 550 to 650 C were estimated for specimens at 65-80 mm distance from the combustion chamber. In order to verify our rock magnetic temperature estimates, heat penetration into the combustion chamber wall was modelled by a one-dimensional approach of convection and radiation free heat propagation in a long thing bar, which is kept at one end at constant temperature whereas the other end is heated and cooled. The model agrees fairly well with the rock magnetic estimates, and moreover it gives an idea about the cooling rates of the specimens in dependence of the distance to the combustion chamber.

Keywords: alteration, baking temperature, archaeomagnetism

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ASI009 **Oral Presentation** **3148**

A mean field model of the magnetic structure in hematite-ilmenite solid solutions and exsolved nanostructures of ilmenite and hematite

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Fabian Karl, McEnroe Suzanne, Robinson Peter

A class of mean field models of lamellar compounds to understand and predict the temperature dependence of Ms in nanoscale layer stacks is presented. Nanostructured compounds, like some of the observed exsolution lamellae in natural hemo-ilmenite and ilmenohematite have magnetic material properties, which are considerably different from those of their bulk constituents. Whenever a hematite lamella has an uneven number of octahedral layers this leads to an uncompensated net magnetic moment. The all these lamellar moments together create a macroscopic magnetization. In our mean field model this is described as one-dimensional sequence of exchange coupled layers. The magnetization Mi of the i-th plane is described by a Brillouin function, the argument of which includes the effective magnetic field generated by the exchange interactions with the adjacent layers. After solving the resulting system of nonlinear equations, the net magnetic moment Ms(T) is obtained as the sum over all Mi. To model bulk solid solutions between ilmenite and hematite, we modify the mean field model by taking into account statistical distributions of Fe^{3+} in the ilmenite Fe^{2+} and Ti^{4+} layers. At 0 K we also minimize the free energy of these systems to find metastable states and possible metamagnetic transitions.

Keywords: hemoilmenite lamellae, mean field theory, nanoscale

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ASI009 **Oral Presentation** **3149**

Rock magnetic methods applied to the study of airborne particulate matter pollution in Rome (Italy)

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In the last years a series of researches was carried out on the magnetic properties of airborne particulate matter (PM) in the town of Rome (Italy). The main aim was to investigate the potential of rock magnetic methods to provide original (independent) proxies for the monitoring of spatial ad temporal trends in air pollution and for the identification of the various pollution sources. The study involved the analysis of trees leaves, collected from various species widely diffused in Rome, and the analysis of air filters, collected over one full year (July 2004-July 2005) in six automatic air sampler stations installed in the whole Latium region (including two stations in the town of Rome). The data showed that the main source of magnetic PM particles in Rome and in the whole Latium region is represented by vehicular traffic and that the intensity of concentration-dependent rock magnetic parameters actually provides a valuable proxy to delineate distribution of anthropogenic PM particles in the urban environment. Tree leaves are passive receptors, with species-dependent capability to accumulate and retain PM particles. Leaves from evergreen species show higher magnetic intensities than those from deciduous species. In general, tree leaves offer the opportunity of a detailed spatial coverage for biomonitoring of air PM pollution. The data indicate strong decay of the magnetic content with an increasing distance from high-traffic roads. Moreover, a variety of magnetic measurements indicate that the magnetic fraction of PM is composed by a mixture of low-coercivity, magnetite-like, ferrimagnetic particles with a wide spectrum of grain sizes, related to different natural and anthropogenic sources. The natural component of PM is very poorly magnetic and has a characteristic magnetic signature that is indistinguishable from that of eolian dust. The anthropogenic PM10 fraction is a mixture of fine superparamagnetic particles and large multidomain grains. Hysteresis data were also used to estimate uncertainties associated with detailed magnetic measurements on small size tree leaf specimens. This contribution will outline an updated overview on the state of the art for this field of research.

Keywords: environmental magnetism, biomagnetic monitoring, particulate matter

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ASI009 **Oral Presentation** **3150**

Magnetic field paleointensity using SQUID microscopy

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Until recently, quantitative paleomagnetic and paleointensity analyses were limited to measurements of bulk samples. The most sensitive of these moment magnetometers are superconducting quantum interference devices (SQUIDs), which measure the net moment of samples typically millimeters to centimeters in size with moment sensitivities of 10-9 Am2. With the recent advent of SQUID microscopy, we have begun to adapt these techniques to map the fine-scale magnetic fields of geological thin sections with spatial resolutions of 100 um and moment sensitivities of better than 10-15 Am2. This affords the possibility of constraining the fine-scale magnetization distribution within the sample. Here we present a detailed paleomagnetic study of basalts from the Hawaii Scientific Drilling Project using SQUID microscopy and moment magnetometry in combination with borehole magnetometry, petrographic and geologic data. We demonstrate how SQUID microscopy can be used to measure the paleointensity of the field which magnetized these basalts 500 k.y. ago. Our high resolution field maps enable us to make thousands of paleointensity measurements on a single thin section which can be correlated with the spatially varying mineralogy, petrologic textures, and alteration zones within the samples. This is the first application of SQUID microscopy to alternating field demagnetization and paleointensity studies. Microscale paleomagnetic imaging affords the possibility of retrieving more accurate paleointensity data from heterogeneous samples that are altered at scales too fine to be distinguishable with moment magnetometry.

Keywords: paleointensity, squid microscopy, paleomagnetism

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ASI009 **Oral Presentation** **3151**

Magnetic properties of nanofabricated synthetic magnetite samples

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Wyn Williams, Chris D. W. Wilkinson, Nikolaj Gadegaard, Haiping Zhou, Adrian R. Muxworthy, Andrew P. Roberts

Due to the ever increasing resolution of microscopic techniques like TEM, SEM, and scanning probe microscopy, it has been shown recently that many geologically important magnetic minerals which were previously thought to be homogeneous, are actually extremely fine intergrowths of ferrimagnetic and paramagnetic minerals. In these fine intergrowths, magnetostatic interactions between ferrimagnetic crystallites will influence remanence acquisition. These interactions can severely bias the palaeomagnetic information carried by intergrown magnetominerals. For a systematic study of interactions it is desirable to have synthetic samples with well-defined grain geometries. We report here on the nanofabrication of two-dimensional arrays of synthetic magnetite particles produced by electron beam lithography and reactive ion etching. These techniques allow us to control grain size, shape and intergrain spacing of large assemblages of magnetite grains. The samples are thus ideally suited to study the influence of magnetostatic interactions on a range of parameters: Magnetic remanence acquisition, magnetic granulometry parameters derived from the measurement of hysteresis loops, first order reversal curves (FORCs), and the effect on palaeomagnetic techniques, e.g. relative and absolute palaeointensity determinations. In this presentation, we will present data on the microstructure and geometry of these samples and discuss low temperature and room temperature magnetic properties and their relation to grain size and magnetostatic interactions.

Keywords: interactions, magnetite, nanofabrication

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ASI009 **Oral Presentation** **3152**

Inverting magnetic data for grain and shape distributions: thermal-fluctuation tomography

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Rock magnetists often use magnetic measurements to analyze the grain-size distribution of magnetic minerals in a sample. Typically, this analysis is only qualitative or semiquantitative. However, researchers have developed a handful of techniques to determine grain-size distributions quantitatively from magnetometric measurement. We present new data demonstrating such a technique: thermal-fluctuation tomography. The technique is based on DC demagnetization curves measured as a function of temperature. Each point on the derivative curves is equivalent to a line integral through the joint-distribution space of grain volume and microcoercivity, f(V, Hk). Using tomography, the data are inverted to solve for f. Our previous results have concentrated on the characterization of nanophase materials, exploiting low-temperature blocking. Here, we expand the results to include stable single-domain grains; including samples of the Tiva Canyon Tuff and magnetotactic bacteria. For these samples, it was necessary to use high-temperature measurements. We further address complications involved with thermal-fluctuation tomography: such as, uniformly-distributed grain orientation, incoherent reversal, and ray-path sampling. We also demonstrate thermal-fluctuation tomography that uses hysteresis loops rather than DC demagnetization curves: hysteresis loops take much less time to measure. Though thermal fluctuation tomography has limitations, it is a new and powerful rock-magnetic tool.

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ASI009 **Oral Presentation** **3153**

Electron Holography in Rock Magnetic Studies

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One of the most significant recent advances in magnetic imaging is the development of off-axis electron holography, a transmission electron microscopy technique that yields a two-dimensional vector map of magnetic flux with nanometer resolution. The technique is capable of imaging the magnetization state within individual magnetic particles, as well as the magnetostatic interaction fields between neighboring particles. Most imaging modes in a TEM suffer from the same drawback: the final recorded image is a spatial distribution of intensity; all information about the phase shift of the electron waves passing through the sample is lost. Electron holography provides an interference pattern from which the phase information can be recovered. Once corrections have been made for variations in sample thickness and mean inner potential, the gradient of the phase shift is proportional to the magnetic flux. Contour lines placed on a holographic image provide a quantitative image of the lines of magnetic flux with approaching nanometer spatial resolution. The high spatial resolution of the technique makes it ideal for the study of nanometer scale particles at the boundary between SD and PSD behavior, and provides the opportunity to study the crystallographic, chemical, and defect microstructures of the sample simultaneously with the holographic measurements. Furthermore, the environment inside a TEM can be carefully controlled to examine magnetization states at varying temperatures and applied fields. Alternatively, oxidizing or reducing atmospheres can be created locally around a TEM sample, making it possible to image the change in magnetization during a minerals chemical alteration. In short, there is enormous potential for advances in our understanding of fundamental mineral magnetism using the technique of off-axis electron holography.

Keywords: electron, holography, tem

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ASI009 **Oral Presentation** **3154**

Low temperature exchange bias of nanoscale lamellar exsolutions of ilmenite in hematite

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Below the ilmenite ordering temperature of 57 K, we observed large shifts of the hysteresisloops in mineral and rock samples containing nanoscale exsolution structuresof ilmenite in hematite. We present a micromagnetic model of such lamellar interfacemoments from ilmenite lamellae in a hematite matrix. The lamellae are eitherplanar, parallel to (0001) of the rhombohedral oxide, or finite isolated nanodots ordisks. The characteristic length scale of the response of the antiferromagnetic matrixto such an isolated embedded nanomagnetic structure is the AF-domain wall width.If the typical lamella size is much smaller than this width, the lamella is comparableto a spherical defect (nanodot). TheAF-sublattice-spin variation then is one-dimensional, depending only on the radialdistance from the defect. The lamella acts as a seed, which by exchange coupling createsa long range spherical AF-spin deflection. Our studies clearlydemonstrate that this system can produce strongly shifted hysteresis loops. We givea systematic overview over the properties of such nanodots, nanodisks, and lamellae,and discuss how to extend this approach to cover also unstructured clouds of nanodotsor highly structured arrays of nanodisks or nanosheets.

Keywords: imenite, hematite, exchange bias

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ASI009 **Oral Presentation** **3155**

Fully automated alternating field demagnetization, ARM and IRM acquisition with a 2G magnetometer

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We report on the performance of our fully automated horizontal 2G system (Model 740R) for alternating field demagnetization, ARM and IRM acquisition that is designed for processing 96 samples without operator interference. All sample manipulation is done by a LabView software package, based on a similar package in Bremen, but adaptated to the specific requirements of the Utrecht hardware and measurement protocols. To ease robotized manipulation, all samples must be contained in cubes with an edge of 30 mm. This enables measurement in more than one position, mandatory for weak (sediment) samples. For room temperature data acquisition the remanence contribution of holder cubes and sample position on the tray is less than 10 pAm^2 (1e-8 emu). To optimize SQUID performance the system had to be equipped with an instrumental electrical ground. Further the 230V AC supplies are generated from a battery stack. Finally, the control of the sample tray was changed to an active sense by infrared sensors and a slit adjacent to each holder position. This was mandatory for smooth robot operation to overcome hysteresis in sample tray positioning caused by the steppenmotor. Samples are mounted in cubic holders and kept in place by silicon kit. This is non-magnetic and easily removable after the (de)magnetization processing, very fragile or powdery samples can be glued over their full face. The system delivers 96 high-quality AF demagnetization diagrams (3 positions, 14 demagnetization levels) in 60 hours. The per-component protocol to cope with GRM takes about 20 hours longer. When the system was restarted in 2007, it has run uninterruptedly for 7 weeks without any downtime. We will show examples of demagnetization diagrams, ARM and IRM acquisition curves acquired for a variety of purposes.

Keywords: demagnetization, instrumentation, laboratoryremanences

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ASI009 **Poster presentation** **3156**

The maximum likelihood solution for inclination-only data

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The arithmetic means of inclination-only data are known to introduce a shallowing bias. Several methods have been proposed to estimate unbiased means of the inclination along with measures of the precision. Most of the inclination-only methods were designed to maximize the likelihood function of the marginal Fisher distribution. However, the exact analytical form of the maximum likelihood function is fairly complicated, and all these methods require various assumptions and approximations that are inappropriate for many data sets. For some steep and dispersed data sets, the estimates provided by these methods are significantly displaced from the peak of the likelihood function to systematically shallower inclinations. The problem in locating the maximum of the likelihood function is partly due to difficulties in accurately evaluating the function for all values of interest. This is because some elements of the log-likelihood function increase exponentially as precision parameters increase, leading to numerical instabilities. In this study we succeeded in analytically cancelling exponential elements from the likelihood function, and we are now able to calculate its value for any location in the parameter space and for any inclination-only data set, with full accuracy. Furtermore, we can now calculate the partial derivatives of the likelihood function with desired accuracy. Locating the maximum likelihood without the assumptions required by previous methods is now straight forward. The information to separate the mean inclination from the precision parameter will be lost for very steep and dispersed data sets. It is worth noting that the likelihood function always has a maximum value. However, for some dispersed and steep data sets with few samples, the likelihood function takes its highest value on the boundary of the parameter space, i.e. at inclinations of +/- 90 degrees, but with relatively well defined dispersion. Our simulations indicate that this occurs quite frequently for certain data sets, and relatively small perturbations in the data will drive the maxima to the boundary. We interpret this to indicate that, for such data sets, the information needed to separate the mean inclination and the precision parameter is permanently lost. To assess the reliability and accuracy of our method we generated large number of random Fisher-distributed data sets and used seven methods to estimate the mean inclination and precision paramenter. These comparisons are described by Levi and Arason at the 2007 IUGG meeting. The results of the various methods is very favourable to our new robust maximum likelihood method, which, on average, is the most reliable, and the mean inclination estimates are the least biased toward shallow values. Further information on our inclination-only analysis can be obtained from: http://www.vedur.is/~arason/paleomag

Keywords: paleomagnetism, inclination only, statistics

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ASI009 **Poster presentation** **3157**

Comparisons of inclination-only statistical methods

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Shaul Levi

Paleomagnetic data from borecores often lack declinations, and the arithmetic means of inclination-only data are known to introduce a shallowing bias. Several methods have been proposed to estimate unbiased means of the inclination along with measures of the precision. Using maximum likelihood estimates, we were able to derive a robust technique of inclination-only statistics for the mean inclination and precision parameter, without making the assumptions and approximations of previous methods. Our method is described by Arason and Levi at the 2007 IUGG meeting. To assess the reliability and accuracy of our method, we generated random Fisher-distributed data sets and used seven methods to estimate mean inclinations and precision parameters. We used true inclination values of 0, 10, ..., 80, and 90 degrees; true precision parameters of 10, 20, 40, and 100; the sample number in each data set was 5, 10, 20, and 100. For each combination, we generated one thousand random Fisher-distributed data sets, and for these 160 000 data sets we calculated the true Fisher mean, also using declinations. For inclination-only data the mean was calculated using the following methods: Arithmetic mean; Kono (1980); McFadden-Reid (1982), using both their original and modified methods; Enkin-Watson (1996) Gaussian-estimates; finally, we obtained maximum likelihood estimates by our new robust technique. In many cases the estimates provided by the previous methods are significantly displaced from the true peak of the likelihood function to systematically shallower inclinations, especially for steep and dispersed data. It appears that the mean inclination estimates of the original McFadden-Reid statistics, still used by some paleomagnetists, is nearly identical to the arithmetic mean, and, in our opinion this method should be abandoned. Comparisons of the results of the various methods is very favourable to our new maximum likelihood method. On average, it gives the most reliable estimates and the mean inclination estimates are the least biased toward shallow values. Further information on our inclination-only analysis can be obtained from: http://www.vedur.is/~arason/paleomag

Keywords: paleomagnetism, inclination only, statistics

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ASI009 **Poster presentation** **3158**

Rock-magnetic studies on experimental fires

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The study of iron mineralogy in archaeological fires and particularly, the ability of magnetic minerals to retain a thermoremanence, can provide valuable information for archaeomagnetic studies as well as help in the interpretation of human activities related with fire production. We have conducted several experiments in order to get a better understanding of the mineralogical transformation involved with burning and their implications in archaeomagnetic studies. Here we present archaeomagnetic and rock-magnetic results obtained from experimental fires carried out in the field. With the employ of an array of thermocouples positioned along the heated surface and at different depths, we have checked the temperatures reached in a clay matrix heated twice during four days. The temperatures recorded ranged from approximately 400C to 650C. Oriented and bulk samples were extracted before and after carrying out the heating in order to perform a complete set of magnetic mineral analyses. In addition to determine the Characteristic remanence (ChRM) by thermal and alternating field demagnetization, rock-magnetic experiments including the measurement of magnetic susceptibility, hysteresis cycles, Isothermal remanent magnetization (IRM) and backfield curves (2T), FORCS, K-T curves and the analyses of the IRM coercivity components, were performed. The reduction of hematite to magnetite is the primary mechanism responsible of the magnetic enhancement of the soil. The thermal alteration of these minerals does not seem to have effect further away than 5 cm of depth, but is highly noticeable in the first 2-3 cm where single-domain magnetite has developed. This kind of analysis appears to validate the suitability of these samplesfor intensity studies. Furthermore, the distinctive thermal impact on the soil can be shown by the changing magnetic properties and the record of p-TRMs and TRMs. The study of these transformations related with burning have direct and significant implications in the reliability of the archaeomagnetic data.

Keywords: fire, rock magnetism, archaeomagnetism

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ASI010 **3159 - 3172**

Symposium
Open Poster Session

Convener : Prof. Helga De Wall
Co-Convener : Dr. Tomasz Werner

This open session is being organized solely as a poster session. In addition to presentations that do not fit directly into the scope of the specific magnetic sessions, we would like to attract contributions which deal with new and innovative aspects and interpretations of magnetic studies. Please feel free to present provacative ideas, interpretations and theories that will be attractive for (heavy) discussions at your poster board.

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ASI010 **Poster presentation** **3159**

Paleomagnetism of Ar-Ar dated volcanics from the Trans-Mexican Volcanic Belt: Contribution to the time-averaged field global database and Geomagnetic Instability Time Scale

Prof. Avto Gogichaishvili
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In this study, we report a detailed rock-magnetic and paleomagnetic investigation of lava flows associated to Trans-Mexican Volcanic Belt (TMVB)- one of the largest continental volcanic arcs of the North American plate spanning about 1000 km from the Pacific to the Gulf of Mexico. 380 oriented samples coming from 62 independent cooling units were collected. All these sites were recently dated by means 40Ar-39Ar systematics and span from 5.7 Ma to 2 ka.. We studied in details three volcanic fields: 1) the Ceboruco-San Pedro, 2) Tequila at the western part of TMVB and 3) Alto de Lucero-Chiconquiapo-Palma Sola areas. Rock-magnetic experiments which included continuous susceptibility and hysteresis measurements point to simple magnetic mineralogy. In most of cases, the remanence is carried by Ti-poor titanomagnetite of pseudo-single-domain magnetic structure. The characteristic paleodirections are successfully isolated for 56 units. The mean paleodirection obtained in this study, discarding intermediate polarity sites, is I = 35.8, D = 0.9 , k = 56, a95 = 5.4. These directions are practically undistinguishable from the expected Mio-Pliocene paleodirections, as derived from reference poles for the North American polar wander curve and in agreement with previously reported directions from nearby lavas of Trans-Mexican Volcanic Belt. This suggests that no major tectonic deformation occurred in studied area. The paleosecular variation is estimated trough the study of the scatter of virtual geomagnetic poles giving SF = 16.1 with SU = 20.3 and SL = 12.3 (upper and lower limits respectively). These values are consistent with the value predicted by the latitude-dependent variation models for the last 5 Ma. The interesting feature of the paleomagnetic record obtained here is an occurrence of intermediate magnetic polarity for two consecutive lavas dated as 2.04 0.04 and 1.97 0.04 Ma respectively, which may correspond to the worldwide observable Reunion event. Two independent lava flows dated as 36213 and 3545 ka respectively, yield transitional paleodirections as well, probably corresponding to the Levantine excursion.

Keywords: paleomagnetism, secularvariation, reversals

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ASI010 **Poster presentation** **3160**

Mineralogy and genesis of Lashak plain clay deposit in the North of Alborz Mountain, Iran

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The studied area is situated in North of Alborz Mountains. Expound of drainage basin is 75 Km2 and its cirque is 15 km2. The purpose of this study is investigation of mineralogy and genesis of Lashak plain clay deposit. Fifty profiles pedology are provided and three boreholes (360m) are excavated. Pedology profiles are shown three groups of inceptisol, mollisol and antisol. XRF and ICP analysis show that TiO_2 and K_2O oxide and Ag, V, Ni, Mo, Cr, Co elements are dominant. Illite, Mica and kaolin are main mineral percentage in the upper top soil. Minerals size is less than 2 micron that originate from bed rock and alluvium deposit. Boreholes sedimentlogy studies indicate that pasadenian orogeny phase effect on this area and filling cirque since 500,000 years. Usually, boreholes lithofacies is high thickness mud, gravelly mud and muddy gravel. Illite, mica and kaolin are major minerals in the boreholes samples and X-Ray analysis show that their crystalline shape. Chlorite, Smectite, Palygorskite and Nontronite are existed in the samples, occasionally. Abundance of these minerals and lack of sedimentary are shown that basal bed rock changing to clay minerals in a burial stages. Palygorskite subhedral crystalline and Illite as a result upper soil PH and lower aluminum oxide in this area.

Keywords: alborz, mineralogy, clay

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ASI010 **Poster presentation** **3161**

Strongly magnetic soils developed on weakly magnetic rock basement

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Eduard Petrovsky, Ales Kapicka, Neli Jordanova

In environmental magnetism, discrimination between magnetic contributions is of great importance. In the case of polluted soils developed on non-magnetic background, magnetic susceptibility is usually strongly enhanced in the topsoil layer (up to 10cm) and rapidly decreases with depth. Contrary to that, in unpolluted areas with strong natural magnetic background (mostly on basaltic bedrock), magnetic signal is increasing with depth. In our contribution we will present and discuss our observations of high magnetic susceptibility of soil samples from unpolluted area, developed on non-magnetic basement rocks (limestones). Our measurements of high frequency-dependent magnetic susceptibility suggest high portion of ultra-fine superparamagnetic magnetite. Mssbauer spectroscopy, SEM observations and rock-magnetic analysis of soil and rock samples were carried out. Based on the first results, we suppose that these soils are influenced by pedogenical processes, which transform initially paramagnetic iron minerals present in the limestones during weathering.

Keywords: magnetite, soils, limestones

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ASI010 **Poster presentation** **3162**

A configuration change in the magnetotail during reconnection?

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On 11 October 2001 Cluster recorded the magnetotail current sheet for an extended period which included the entire duration of a reconnection event. We use maximum variance analysis to determine the orientation of the ambient magnetic field outside the current sheet. Before reconnection the ambient field direction at the Cluster site was almost radial, but at the onset of reconnection the ambient field became more aligned with the X axis. The new orientation persisted when reconnection ended. The sudden orientation change of the magnetic field was also observed by Goes-8 at geostationary orbit, and ground magnetometers recorded simultaneously signs of a westward electrojet. Solar wind and interplanetary magnetic field were quite steady during the event and thus did not induce the orientation change directly. We hypothesize that the onset of reconnection may have been associated with a large-scale, possibly global, configuration change of the tail.

Keywords: magnetotail, reconnection, cluster

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ASI010 **Poster presentation** **3163**

Magnetic Perturbations seen by CHAMP and evaluated using the TIE--GCM

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IAGA

Mioara Mandea, Joseph Cain

The NCAR Thermosphere-Ionosphere Electrodynamic General Circulation Model (TIE-GCM) is a self-consistent, global, atmospheric model which can be used to estimate magnetic perturbations at satellite altitude. These computed perturbations can then be compared with the magnetic vector data provided by low-earth orbiting satellites. In this initial study, the quietest day of each month from 2001-2005 was selected for comparison. CHAMP magnetic vector residuals were computed for these intervals using the CHAOS model to remove the core and crustal geomagnetic contributions. Under various input parameters, the TIE-GCM predictions were compared with the CHAMP residuals on an orbit by orbit basis. Initial results demonstrate a reasonable agreement between the TIE-GCM estimates and the CHAMP residuals in non-polar, dayside regions (+/- 50 latitude) where both are able to resolve the Equatorial Electro-Jet (EEJ) and Solar Quiet (Sq) current systems. However, no clear component or temporal correlation was discerned. Evidence showing the decrease in residual comparisons presents the the possibility of using the TIE-GCM to pre-process geomagnetic data for main field modeling purposes.

Keywords: tie gcm, geomagnetism, champ

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ASI010 **Poster presentation** **3164**

Magnetic signature of atmospheric PM10 from sites with different environmental stress

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Atmospheric particulate matter of anthropogenic origin contains significant portion of minerals with pronounced ferrimagnetic properties. These minerals, mostly iron oxides, can serve as tracers of industrial pollutants at the sites of PM10 collection and the neighbouring soils. Quite often, significant correlation can be found between magnetic parameters reflecting concentration of these particles (namely saturation magnetization and magnetic susceptibility) and concentration of heavy metals (e.g., Pb, Zn, Cd, etc.). This relationship has no general validity and is site-characteristic. Despite that, once determined, fast and cheap magnetic measurements can help in assesing the concentration of heavy metals and thus in monitoring the environmental stress at different sites. In our study, we have investigated PM10 collected in different periods of a year at sites characterised by various environmental circumstances (industrial, traffic, urban, urban background and regional background). In this contribution, we will show and discuss regional variations in magnetic parameters, characterising concentration of magnetic fraction of PM10, and those parameters related to grain-size distribution. For instance, our results clearly show that PM10 at the industrial site has constant mineralogy and grain-size distribution in different periods of a year, determined by constant composition of the pollutants emitted in the atmosphere from the close sources. Contrary to that, PM10 from urban and regional background sites can be clearly distinguished from the particles collected at the industrial site.

Keywords: magnetic, atmospheric, pm10

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ASI010 **Poster presentation** **3165**

Analysis of geomagnetic observations made in Rome around the year 1790

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Angelo De Santis

Magnetic declination was measured on a regular basis three times per day in Rome, Italy, in the 1780ies and 1790ies as part of a network to measure mostly meteorological parameters in various European cities. This network was organized by the Societas Meteorologicae Palatinae.The magnetic measurements were performed under homogeneous conditions in the morning, midday and evening and the results are given to an accuracy of 3 minutes of arc. The data from Rome is special because of its high quality compared to other stations of the network. In particular, the data resembles today's daily solar quiet variation and its annual modulation. We present an analysis of this historic dataset and compare it to modern geomagnetic observatory data.

Keywords: geomagnetism, rome, historic

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ASI010 **Poster presentation** **3166**

Measurement and compensation of the Earth's magnetic field using a cesium optical pumping magnetometer

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The optical pumping polarization in the vapor of alkaline metal(133Cs) for atomic magnetic resonance(AMR) is used to measure a precision magnetic flux density. The main advantages of the AMR technique in comparison with traditional nuclear magnetic resonance(NMR) consist in a million times larger polarization effect. Therefore, the sensitivity and uncertainty of AMR are better than NMR method in low magnetic field range. The earths magnetic field(EMF) measurement system consists of couple of the 3-axis Hemholtz coils serially connected main and auxiliary coil for EMF control, three current sources for compensation coil of the permanent EMF, Cs-AMR magnetic field controller for the measurement and compensation of time-varying EMF. The equipments were installed in nonmagnetic laboratories, which are away from the artificial magnetic field noise sources. The main and the auxiliary coil systems were set up in a distance of about 50 m distance from the each other in order to delete of mutual magnetic field dissipation and the effect of the other magnetic field sources which can be used in the main coil system. Those coil systems are composed of the two windings per component having the same coil constants and coaxial axis and used for the compensation of the permanent EMF and time-varying EMF variations. Each of the permanent EMF winding systems is supplied with the appropriate current by dc current sources. Small differences of coil constants between the main and the auxiliary coil system are trimmed by the shunt resistors. The time-varying EMF variations and the current instability are compensated by the Cs-AMR controller, the sensor of which is placed in the center of the auxiliary coil system. The residual magnetic field drift in the working place of the coils is determined by the following parameters like coil constants, coils axis direction, local field variations and temperature drift in the two coil systems. In this paper the results of measurement and compensation of the EMF using a Cs-AMR magnetometer will be discussed in detail.

Keywords: earth magnetic field, magnetometer

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ASI010 **Poster presentation** **3167**

Magnetospheric Line Radiation observed by a low altitude satellite: classification, sources and theory of propagation

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We present a systematic study of Magnetospheric Line Radiation (MLR) observedby a low altitude satellite. Almost three years of data measured by the DEMETERspacecraft (launched in June, 2004, altitude ~700 km) and an automaticidentification procedure of MLR events have been used in order to obtain astatistically significant data set. Two principally different classes of eventshave been found and their properties (intensity, frequency, time duration,bandwidth of individual lines) have been thoroughly investigated:1) Events with frequency spacing of 50/100 or 60/120 Hz (Power Line HarmonicRadiation, PLHR). The artificial origin of these events from power systems isdemonstrated. Penetration characteristics of ionosphere are evaluated toexplain a difference in the intensity of PLHR observed during the day andthe night.2) Events with frequency spacing different from frequencies of power systems("real-MLR"). These emissions usually occur at lower frequencies, often in ELFband where all the 6 components of the electromagnetic field are measured.A detail analysis of those events is performed, their propagationcharacteristics are studied and possible source locations are determined.

Keywords: ionosphere, man made, mlr

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ASI010 **Poster presentation** **3168**

Information center based on Nagycenk Geophysical Observatory (GGRI of HAS) data

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Viktor Wesztergom, Kroly Kovcs

Nagycenk Geophysical Observatory (IAGA code: NCK) maintained by the Geodetic and Geophysical Research Institute of Hung. Acad. Sci. was founded in 1957, in the year of International Geophysical Year. The observatory was purpose built for ground based monitoring of the Earths environment. Measurements and reports started in the same year with earth current data. Continuous observation of atmospheric electricity and geomagnetic elements started in 1961, while ionospheric measurements began in 1967. Since 1993 Schumann resonance measurements have been carried out, and a meteorological station was installed in 1996. The observatory belonged to the INTERMAGNET co-operation since 1993, and the data are transmitted via METEOSAT satellite to geomagnetic information nodes. The yearly number of electronic citation for NCK data is approximately 3000-3500. In the frame of Regional Earths Environment Center project (started in 2005) we offer a wider accessibility to NCK data by formation of a virtual observatory (www.reec.hu portal). The forming database will be completed with atmospheric electricity (such as potential gradient, lightning, Schumann resonance and VLF whistler observations), ionospheric (based on the newly installed ionosonde) and geomagnetic data (hourly and daily mean values of H D Z, derived K index) also. Besides real time access to certain data such as magnetic recordings , archive data for 50 years, interpretations and tutorial materials will improve the portal.

Keywords: geophysical, observatory, database

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ASI010 **Poster presentation** **3169**

Paleomagnetism and Secular Variation in Southern Patagonia Plateau Lavas, 46S to 52S, Argentina

Dr. Laurie Brown
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Daniel Mason, Matthew Gorring, Christopher Condit

Southern Patagonia, Argentina (46S to 52S latitude and 68W to 72W longitude) is the focus of a regional study of secular variation of the Earths magnetic field over the past 5 myr, by investigating the paleomagnetism of Plio-Pleistocene lava flows. Volcanic activity in this area is related to back arc volcanism due to slab window activity as the South Chile Ridge is subducted under South America, producing Neogene volcanic plateaus capping the Mesozoic basement far to the east of the active plate boundary. Published studies on young lavas from both the northern (Meseta del Lago Buenos Aires, Brown et al, 2004) and southern (Pali Aike Volcanic Field, Mejia et al, 2004) provide acceptable paleomagnetic data on nearly 70 lava flows. Paleosecular variation values for the two studies differ, with 17.1 obtain for the Pali Aike field and 20.0 for the Lago Buenos Aires field. Recent fieldwork in the plateau lavas between these two sites has provided some 80 new sites for study to better investigate secular variation and the time-averaged field over this entire region during the past 5 myr. Rock magnetic studies on selected new samples (isothermal remanent magnetization and hysteresis measurements) as well as optical observations indicate low titanium magnetite as the primary carrier of remanence. Thirty-three new sites, most from Gran Meseta Central (48S), yield a mean direction of inclination 61.8, declination of 356.6 with an alpha-95 of 5.7. These directions, with additional sites recently collected from Meseta de la Muerte south to Rio Santa Cruz, will allow us to further investigate paleosecular variation in this region.

Keywords: paleomagnetism, paleosecular variation

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ASI010 **Poster presentation** **3170**

A statistical analysis of simultaneous Pc3 pulsation and whistler activity

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Balzs Heilig, Arpad Kis, Jnos Lichtenberger, Werner Magnes, Tmea Prodn, Judit Szendrői, Massimo Vellante, Viktor Wesztergom

The continuous recording of ULF and VLF waves in Hungary was supplemented several years ago with an automatic whistler detector by the Space Research Group of Etvs Lornd University. In the frame of the research work conducted by the SEGMA (South European GeoMagnetic Array) group we have at disposition high time resolution (one second sample rate) geomagnetic data from four meridional observatories. The northernmost station of the SEGMA is Nagycenk Geomagnetical Observatory (NCK) which is also equipped with a VLF receiver antenna and recording unit. The availability of the good quality data provides a unique opportunity to performe a detailed comparative analysis of simultaneous ULF and VLF activities. In this study we also compare our conclusions with previous results based on lower time resolution data and less representative statistics. Meridional observatory array data offers the possibility to separate upstream wave type and FLR type pulsations. The correlation between FLR type pulsation frequency and the L value of whistler propagation is also examined. This present study covers the whole 2003 year which contains time periods of extremely high geomagnetic activity.

Keywords: pulsation, whistler

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ASI010 **Poster presentation** **3171**

Analysis of long term behaviour of geoelectric activity at Nagycenk Geophysical Observatory

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Andrs Koppn, Istvn Lemperger, Tmea Prodn, Judit SzendrőI, Viktor Wesztergom

Measurements at Nagycenk Observatory (IAGA code: NCK, L = 1.9, φ = 4738', λ = 1643', altitude = 153.70 m) has been providing over the last five decades a special activity index called the T index. This index is hand-scaled from continuous telluric (geoelectric) recording. The telluric field is generated by the time variation of the geomagnetic field (curl E = - ∂B/∂t) therefore T characterizes the higher frequency components in comparison with the magnetic range indices. We study the long-time behavior and variability of the Earth geomagnetic activity based on the uniquely long geoelectric field observations recorded at the Nagycenk Geophysical Observatory. Statistical analysis of the T index confirms the general characteristics of the geomagnetic activity known from numerous former studies. Nevertheless, we also found slight differences which in our opinion are due to the dominating higher frequency variations. According to our results there is no clear correlation between the solar activity (expressed in sunspot number) and the daily T index. On the other hand, we found an almost linear relation between the Ap and the T indices.

Keywords: geoelectric, geomagnetic, tindex

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ASI010 **Poster presentation** **3172**

In-situ TEM observation of the interaction between magnetic domain walls and twin domain walls below t he Verwey transition in magnetite

Mr. Nathan Church
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The Verwey transition has an enormous impact on the magnetic properties of magnetite at low tempeatures the magnetocrystalline anisotropy increases by an order of magnitude and the magnetic easy axis switches from the <111> directions of the cubic phase to the [001] direction of the monoclinic phase. On cooling through the transition, the [001] easy axis of the monoclinic phase may be chosen to lie along any one of three <100> directions of the parent cubic phase, resulting in the development of transformation twinning. Numerous studies have proposed that a strong interaction exists between the ferroelastic twin walls and the ferrimagnetic domain walls in magnetite. Nevertheless, the nature of this interaction remains highly controversial. Key questions include: i) are the ferroelastic twin walls strongly pinned, or can they be moved by application of a stress and/or magnetic field? ii) are magnetic domain walls strongly pinned by the twin walls or can they be moved indepedently? and iii) how does the twin microstructure that develops on cooling through through the transition depend on the magnetic microstructure that exists above the transition, and vice versa? To address these questions we have performed an in-situ study of the cubic to monoclinic phase transition in synthetic multi-domain magnetite using low-temperature transmision electron microscopy. The Fresnel mode of Lorentz microscopy was used to make simultaneous observations of the nucleation and translation of transformation twins and magnetic domain walls as the sample was repeatedly cycled through the phase transition. The phase transition is first-order in character and proceeds by the rapid movement of an abrupt phase interface separating the cubic and monoclinic phases. For temperatures just below the transition point, heating of the sample by the electron beam is sufficient to cause rapid movement of the phase interface and internal rearrangement of the transformation twins within the monoclinic phase. There appears to be little twin memory, i.e. a different set of transformation twins is often observed each time the sample is cooled through the transition. The distribution of magnetic domains above and below the transition was generally very different. The cubic phase is characterised by a low density of magnetic domain walls, whereas the monoclinic phase contains a higher density of closely-spaced lamellar domains. In contrast to previous studies, magnetic closure domains within the monoclinic phase were also observed to be relatively common. Regions showing a clear interaction between magnetic domain walls and twin domain walls were observed. Typical features include the pinning of magnetic domain walls at the tips of needle twin domains and the shearing of needle twins by an intersecting magnetic domain wall. Preliminary work focussing on the magnetic structure of the twin domain boundaries using electron holography will also be presented.

Keywords: magnetite, verwey, electron

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ASI011 **3173 - 3200**

Symposium
Environmental studies

Convener : Dr. Maxwell Meju
Co-Convener : Dr. Claudia Mabel Sainato, Prof. Gad El-Qady

Advances in digital technology and concurrent developments in instrumentation and multi-dimensional inverse numerical modelling have led to improved data acquisition and interpretation techniques as well as brought geophysical (and in particular electrical and electromagnetic) methods within range of their theoretical resolving capability in near-surface investigations. This session focuses on novel applications of electrical and electromagnetic methods or their combination with other methods to address challenging environmental problems. We invite contributions that deal with, but not limited to, the following: (i) 3D investigations of derelict or contaminated land and groundwater resources; (ii) New non-invasive procedures for tracking or monitoring the progress of soil degradation (e.g. by chemical loading from agricultural activities) and bioremediation; (iii) Remote prediction of petrophysical and hydrochemical attributes of near-surface targets; (iv) Development of robust surface-process models and correspondence principles for geophysical anomalies; (v) Improved integration of field and lab techniques (multi-scale approaches) and time-lapse characterisations; and (vi) Sophisticated integrative mathematical models and controlled field experimental studies.

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ASI011 **Oral Presentation** **3173**

Controls on methane gas localisation in a covered wetland-hosted landfill site as inferred from integrated analyses of electrical resistivity, hydrological and hydrochemical data

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A combined electrical, hydrological and geochemical approach has been used to determine the possible controls on methane gas localization in an old covered landfill site with domed cover situated in marshland. Long-term geochemical monitoring data from six wells reveal a strong correlation between changes in water level and methane-to-carbon dioxide ratio. The data also show temporal changes in fluid electrical conductivity for low-methane wells but time-invariance for high-methane wells. Multi-dimensional resistivity models derived from six survey lines passing through these boreholes successfully define the internal landfill structure (resistive top soil, conductive clay cap, resistive unsaturated fill, conductive saturated fill and substrate). Localized 3D resistivity imaging reveals a trough-like conductive feature in a central zone of maximum elevation, coincident with lowered water level, and flanked by elevated conductive shoulders. Geochemical measurements show that this trough-like zone is characterized by high CH4-to-CO2 levels (85:15 volume %), moderate alkalinity (<2300 mg/l), low fluid conductivity (~500 mS/m) and low chemical-cum-biological oxygen demands, while the flanking regions have lower levels of CH4 and CO2 (65:35 vol. %) and high fluid conductivity (>1000 mS/m), alkalinity (>3500 mg/l) and chemical-cum-biological oxygen demands. We interpret these coincident features as suggesting a possible preferential flow through the site and methane accumulation against the local hydrodynamic gradient in a flushed zone while the flanks are relatively stagnant zones. This paper suggests that these results have implications for efficient targeting and recovery of concealed methane deposits in landfill sites to address greenhouse or renewable energy problems. It is also suggested that for energy resource sustainability, such a wetland-hosted facility should be designed to safely interact with the potentially methane-laden water from the surrounding wetlands.

Keywords: landfill methane, hydrogeochemistry, geoelectricity

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ASI011 **Oral Presentation** **3174**

Computational simulation of heat transfer enhancement from surfaces with cavities

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Three-dimensional single and multiple cavity flows with heat transfer enhancement are investigated. Cavities are composed of spherical dimples with various depths and dimple distances. They are placed on a flat, heat-conducting channel. When fluid flows over the cavities, its flow characteristics such as pressure, temperature, velocity profiles, and turbulent shear stresses change. This study investigates the relationship of these characteristics to the heat transferring phenomena on the surface. The results of the computational study of the impact of single concave cavity on the aerodynamic resistance and heat transfer coefficient compared with experimental data are presented. The study involves advanced computational techniques in modeling and simulation and is relevant to problems on earth and in space dealing with surfaces.

Keywords: cavities, computation, simulation

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ASI011 **Oral Presentation** **3175**

Infiltration experiments at meter-scale and inversion strategies for time-lapse resistivity tomography

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The process of water infiltration into and through the soil determines groundwater recharge, gives insight into groundwater vulnerability, contaminant transport, soil erosion risk, and bears valuable information for water cycle estimates. Whether the water infiltrates slowly and continuously through the soil or whether it uses preferential pathways for faster infiltration is one of the most critical questions. Dynamic electrical resistivity tomography is increasingly used to actually visualise the infiltration process and show preferential pathways, if they exist. Although the electrical resistivity gives ambiguous information on the absolute water content, resistivity changes can, under certain assumptions, uniquely be attributed to relative water content changes. The experimental setup consists of a small well defined infiltration area fed by a volume and time controlled irrigation device located at the centre of a rectangular array of 200 electrodes with 20cm grid spacing. Resistivity array measurements are carried out during and after the irrigation. Various time lapse resistivity interpretation strategies are used to study these water content changes in time. The inversion of the resistivity data, however, solves an ill-posed problem, and the inversion method uses more or less justified constraints that bias the results. Particularly the smoothness constraints, used in many inversion attempts, are of peak importance. These constraints inevitably smooth small preferential pathways and suggest a bathtub like infiltration plume. The strategy of model-sided robust inversion, aimed at reducing this effect, is mostly implemented as decreased penalties of strong resistivity contrasts. This approach still smoothes the model and tends to combine smaller structures to bathtub like figures. On account of this the infiltration velocity is possibly considerably underestimated thus rendering aquifers better protected than they really are. Model studies and the well defined infiltration experiments show that the often preferred smooth inversions nearly always suggest the infiltration as smooth bath tube structures, even if smaller preferential pathways are present. The real infiltration depth is underestimated because the preferential pathways are obscured by the smoothing. Inversions without smoothness constraints enable the detection of preferential pathways but this advantage is paid for by the occurrence by obvious artefacts, shown as resistivity increases. As bigger the resistivity contrasts get and as more heterogeneous the soil is as stronger are these artefacts. The problem can partly be counteracted by artificially introducing the observed resistivity changes in a homogeneous model and inverting these data without smoothness constraint. By this technique smaller preferential pathways are visible that clearly would have missed out using the classical time lapse inversion strategies.

Keywords: resistivitytomography, infiltrationexperiemts, preferentialflow

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ASI011 **Oral Presentation** **3176**

Mapping peat layer using integrated surface geoelectric techniques: Case study at eastern Nile Delta, Egypt.

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The shallow subsurface of the Nile Delta, Egypt is inhabited with peat layer of maximum thickness about 3.5 meters and depth varying from 5 to 15.5 meter. The hazardous properties of peat layer, which affects the infra structures, can be categorized as the great capacity for tacking up and holding water, high shrinkage on drying, high permeability, low shear strength and high compressibility. Consequently, from the engineering point of view, peat is often unstable for supporting any kind of structure and considered as the worst kind of foundation materials that may encounter in the substrata. In this study, the area of southern Mansoura city, Nile Delta was surveyed using shallow geoelectric tools aiming to delineate the peat extensions in order to assist engineers for future planning of the infra structures. The survey includes a self-potential (SP), induced polarization (IP) and time domain electromagnetic (TDEM) techniques. The results showed that the peat layer is associated with relatively higher chargeability than the surrounding sediments. The depth to peat layer that is inferred from the SP, IP and TDEM profiles is coinciding with the available borehole data. The thickness of the peat layer inferred from the TDEM results is highly correlated with the borehole data. However, the thicknesses of this high chargeability zone in IP-sections are poorly depicted. That may be due to the screening effect of IP response to current flow through deeper parts. The average values of depth and thickness were calculated along each profile to construct isopach and depth to peat layer maps in the study area. The integration of these maps and the available borehole data give detailed information about the distribution of peat layer rather one data alone. As a conclusion, it is strongly recommend to applying a similar survey at the new proposed dwelling zones in Nile Delta area, prior any planning for constructions, to give detailed information about the subsurface distribution of peat.

Keywords: geoelectric, peat, niledelta egypt

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ASI011 **Oral Presentation** **3177**

Hydrocarbon contaminated soils and magnetic response

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A correlation of magnetic parameters with the presence of hydrocarbons in soils was demonstrated in several studies. The change of soil magnetic properties depends on biogeochemical transformation of magnetic iron minerals. Iron metabolizing microorganisms can get stimulated by hydrocarbons or their degradation products and lead to the (trans-) formation and/ or dissolution of magnetic iron minerals, which change the soil magnetic properties. Our study aims to investigate the change of magnetic properties of hydrocarbon-contaminated soils, both in natural field conditions and in laboratory batch experiments simulating hydrocarbon contamination. The field study area with natural oil outcrops is located at the former oil field Hnigsen in Northern Germany. Oil has been exploited at this site for more than 400 years. The soil is sandy and contains sections which are heavily contaminated with hydrocarbons. Therefore, the hydrocarbon-induced changes of magnetic properties of the contaminated soil can be discriminated from clean soil. The initial measurements of magnetic susceptibility at the field site showed moderately increased values in the hydrocarbon-polluted soil. A laboratory study has been performed in batch experimental setups. The setups vary in soil type, soil microbiology (sterilized and untreated), soil contamination (non-contaminated and contaminated) and substrate addition (no addition, water, lactate-acetate mixture and unleaded petrol). The experiments are followed for several months to monitor changes in magnetic mineralogy under the influence of geo-microbiological processes and hydrocarbons. Weekly monitored magnetic susceptibility data, as well as magnetic characterization of original soil and of soils used in different setups will be compared at the end of the experiment. After several weeks of monitoring, there is a change (both increase and decrease) of magnetic susceptibility with time in all setups with non-sterilized soil. Sterilized samples did not show a significant change. Additionally, the influence of added hydrocarbons on the soil microbial community will be determined by analyzing the diversity of the microbial population in the original soils and in the setups by the molecular fingerprint technique DGGE.

Keywords: magetic proxies, iron metabolising bacteria, hydrocarbon contaminated soil

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ASI011 **Oral Presentation** **3178**

Geophysical investigation of saline intrusion near the Bevano River mouth: preliminary results

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In Italy as in many other mediterrenean countries, coastal dunes have been destroyed by poor land use and coastal management policies adopted in the past. During the seventies, tourism development caused a rapid disappearance of dunes along many stretches of the North Adriatic coast. Since coastal dunes act as a coastal resilient factor against erosion and saltwater intrusion, it is very important to understand their dynamics in order to protect them. The Province of Ravenna (Italy) is particularly affected by subsidence, that causes lowering of already depressed areas and worsens the saltwater intrusion phenomenon. Along this coast, dunes are the only element that lay above mean sea level. Since dunes have a great infiltration capacity, they can accumulate fresh groundwater. As a result, the water table by standing above sea level acts as a hydrostatic control on saltwater intrusion, according to the Ghyben-Herzberg equation. An undisturbed and well developed dune system is, therefore, effective in contrasting saltwater intrusion. The main objective of this study is to evaluate how effective are the coastal dunes in contrasting saltwater intrusion in the Province of Ravenna. This kind of information is important for Integrated Coastal Zone Management purposes. In the Province of Ravenna, the Bevano River Mouth Natural Reserve is the only stretch of coast where dunes are continuous, undamaged and natural looking; for this reason we chose to characterize this area first. The Bevano river mouth also includes wetlands and pine forests that are very sensitive to saltwater intrusion.. The western area of the Bevano Mouth(named Ortazzino) includes abandoned meanders, coastal dunes and brackish-water wetlands.The wetlands and the river mouth have recently undergone a change due to the river course artificial rerouting in proximity to its mouth. Twelve Vertical Electrical Sounding (VES) and measurements in four piezometers have been carried out. The interpretation of the electrical images combined with the observation of direct field data (groundwater level, water conductivity in piezometers), allowed us to develop a model for the salt-fresh water boundary. An attempt at reconstruction of the freshwater lens shape has been made. Its maximum thickness corresponds to the highest points of the dunes and it gets lower in proximity to the river mouth. The maximum extension of the lens corresponds to the only area where there is no pine forest. Results highlight that even in a protected area the influence of human influence on the landscape is very strong. The artificial pine forest which lays behind the dunes, in fact, has a negative impact on saltwater intrusion, since evapotranspiration from pines acts as water withdrawal well.

Keywords: coastal dunes, saltwater intrusion, resistivity

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ASI011 **Oral Presentation** **3179**

A new method of geo-electrical survey of saltwater-freshwater interface

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We would like to report some results of development of a new method of geo-electrical survey of saltwater-freshwater interface in the coastal zone and mathematical analysis of the 3-D structure of the geo-electrical data obtained near the boat basin in Donnalucata in the province of Ragusa along the southeastern coast of Sicily, . The survey and geo-mapping spatial distribution of the saltwater-freshwater interface in the coastal zone were conducted during the IAEA submarine groundwater discharge (SGD) experiment in Sicily. We have been using the MARSES TEM sounding instrument, which has been developed at the Russian Academy of Sciences, based on time-domain electromagnetic sounding technology. Using TEM technology it is possible to conduct a subsurface sounding to a depth of up to 300 m. Our study have shown the presence of two layers with various mineralization of subsurface waters in the coastal zone of Donnalucata. The geo-electrical data have been taken for two subsurface zones with different type of subsurface water: resistivity = 5.37 Om-m and with mineralization of the groundwater on the order of 2000-2500 mg/L (basic water-sated horizon from 5 meters up to 15 meters in depth), and a second zone (depths from 50 meters up to 70 meters) with resistivity = 3.32 Om-m and mineralization of groundwater on the order of 4500 - 5000 mg/L. Maximum discharge reflects the specific geological structure in the display of karstic groundwater phenomena of the coastal zone of Donnalucata, and provides a conceptual framework for understanding the effects of SGD processes in the coastal zone. Analysis of geo-electrical data have show the reason for the increase maximum SGD in the domain of measurements as revealed according to the results obtained by some other methods and different tools used in the offshore zone in the channel between two piers of the boat basin.

Keywords: near surface environment, geo electrical survey, groundwater interface

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ASI011 **Oral Presentation** **3180**

Palaeovalley characteristics revealed by shallow geophysical and hydrogeological observations

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Palaeovalleys are common geomorphic featuresthat often contain sediments deposited by formerly active streams or rivers. Flow in these valleys may have been disrupted by tectonic movement or climatic change. In , palaeovalleys are recognised to contain considerable thicknesses of sediment that date from the Mesozoic through to the late Cainozoic. These sediments are known to host, or act as pathfinders to economic mineralization, and are an important source of potable groundwater, particularly in remote areas. For these reasons, State and Federal Governments are funding programs which include geological, geophysical and remote sensing studies to systematically map palaeovalleys. Geophysical techniques are non-invasive procedures for obtaining information about the sub-surface without the need for extensive drilling. Some of the geophysical techniques used to map palaeovalley sediments include electromagnetics (EM), DC resistivity, gravity and magnetic field measurements. These measurements can be used to derive important hydrogeological information such as depth to the water table, salinity of groundwater, presence of clay, thickness of weathering, depth to the basement rock and location of fractures or faults; which may constrain groundwater flow. Ground-truthing of these non-invasive measurements can be done by using down hole geophysical measurements such as down hole EM as well as geological/ hydrogeochemical sampling. The Tanami Desert Region of Northern Australia is an emerging gold province in. Although not genetically related, some of the gold deposits are located on the margins of palaeovalleys. Outcrop in these areas is sparse and bedrock is generally covered by in situ and transported regolith materials. As part of the research activities of Co-operative Research Centre for Landscape Environments and Mineral Exploration (CRC-LEME), we have carried out ground transient electromagnetic (TEM) and down-hole EM measurements as well as hydrogeochemical sampling of the open drill holes at the Titania mineral prospect. Apart from identifying possible locations of mineralisation, these studies have clearly delineated the character of the palaeovalley sediments and the properties of the groundwater. A detailed discussion on the multidisciplinary approach of this CRC LEME project will be presented.

Keywords: palaeovalley, geophysics, hydrogeology

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ASI011 **Oral Presentation** **3181**

Deep multiaquifer system: hydrogeological exploration integrated with geophysical data

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The need for good quality fresh water is becoming a global emergency, for both growing exploitation and pollution of water resources. As far as groundwater resources are concerned, they can be threatened both for pollution by human activities, especially in the recharge areas, and, in many cases of overexploitation, by the rising up of deep brackish/salt water. Saving this precious resource demands detailed knowledge of the subsurface, of the potential sources of pollution and of the equilibrium between exploitation and recharge processes. At the same time information about the whole sequence of aquifer bodies at the greatest depths becomes a strategic priority. Careful control and management activities should then be undertaken by public Authorities.In this spirit, in the western sector of the Friuli-Venezia Giulia region (northern Italy) analysis of a large amount of lithological, geomorphological, hydrological and hydrogeological data allowed us to define a) the principal aquifer system of the area down to a depth of about 500 m; b) the geometrical characteristics of the aquifers (thickness, lateral extension,..); c) the hydraulic parameters (permeability, transmissivity); and d) the vulnerability to pollution of each aquifer system. The studied area was chosen since it is characterized by a rich but vulnerable groundwater reservoir, generally composed of several aquifer bodies, each of them giving abundant and good-quality fresh water.In a selected portion of the area, where many holes were drilled for fresh water supply, the conceptual hydrogeological model was integrated by a detailed and repeated three-dimensional (3D) seismic and resistivity survey. The 3D resistivity models, which are described in this paper, were obtained using combined Electrical Resistivity Tomography (ERT) and Time-Domain ElectroMagnetic soundings (TDEM). ERT was mainly used to get detailed information about geometry and porosity of the overburden and to calibrate the shallowest TDEM information. TDEM survey in its turn gave reliable results both about the geometry of deepest aquifer and the repeated TDEM surveys show resistivity variations in the exploited aquifers which are in good agreement with direct hydrogeological information.

Keywords: groundwatermonitoring, friuliveneziagiuliaregion, electricalresistivitytomogry

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ASI011 **Oral Presentation** **3182**

On the geoelectric monitoring at the CO2 sequestration

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The global warming is one of the most serious environmental problems of the day and is possibly due to the rapid increase of the atmospheric CO2 concentration by man-made economical activities. CO2 reduction is of the most importance to prevent the Earth from various disasters. Fossil fuel, which is big source of the atmospheric CO2 and shares one-fourth of the CO2 in the atmosphere, has to be suppressed to use and the utilization of non-fossil renewable energies should be encouraged. The energy conversion from the fossil to the renewable energies is, however, hard to conduct. Bridge technology is therefore necessary to use the fossil fuel and to keep the activities. CO2 capture and storage (CCS) is one of the most feasible methods among the bridge technologies. There are several options on the storage of CO2 in the CCS program. One of the options is to store CO2 in a geological formation. CO2 is stored for a long time in the geological formations of oil, gas, and coal layers and the geological formations have large capacity to store. However we have to inject CO2 into the geological formations without environmental impacts. Monitoring is, therefore, necessary not only during but also after CO2 injection in order to show how CO2 is stored in the geological formations. Time-lapse seismic measurements were carried out to demonstrate CO2 migration within the aquifer and no leakage beyond the cap rocks happened in the CO2 sequestration fields. The seismic monitoring creates high accurate reflection images, which are very helpful to understand the movements of CO2 . The survey using the active source, however, does not provide the continuous change of CO2 . Measurement tools with passive sources are also necessary to monitor the CO2 migration continuously. We have carried out geophysical and geoelectric measurements during the air and CO2 injections at a test field. High resisitivity of more than 1,000 ohm-m was observed with low resisitivity horizontal layers corresponding the aquifer. The increase of the resisitivity was observed at the aquifer after the air injection. It implied that air intruded into the aquifer layers around the injection well and water migrated into the dry and unsaturated layers, resulting in the increase of the resisitivity. The increase of SP was apparent starting after the injection and was larger close to the injection well, implying that the change was cause by the air injection. One of the reasonable explanations on the phenomenon is that the change was caused by the oxidation-reduction (redox) potential change. The redox potential is often observed around the conductive ore deposit. An electron moves to oxidization environment at the surface from reduction environment at the subsurface when a conductive object exists connecting the both environments, resulting in the negative SP anomaly at the surface. The air injection increased oxygen partial pressure at the aquifer around the well and decreased the electron movement along the conductive casing pipe. The apparent change of resisitivity and SP were also observed by the CO2 injection. The geoelectric monitoring technique as well as the seismic monitoring is possible for the monitoring in the CCS project.

Keywords: co2, self potential, monitoring

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ASI011 **Oral Presentation** **3183**

Integrated Geoelectrical survey for groundwater and shallow subsurface evaluation: case study at As Sillein spring, El Fayoum, Egypt

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As Sillein is one of the natural, fresh water springs distributed in the western desert of Egypt. It is located in the hart of El Fayoum delta within very promising area for sustainable developments and tourist activities. Integrated geoelectrical survey for mapping groundwater resources and shallow subsurface investigation was conducted to help in planning the future developments in the area. Twenty eight Transient Electromagnetic (TEM) soundings, three Vertical Electrical Soundings (VES) and three Electrical Resistivity Tomography (ERT) profiles were carried out around the spring location. The densely cultivation and irregular topographic features hindered acquiring more VES and ERT data. The TEM data have been inverted in combined manner with the VES, ERT and the available geological information. Based on the inversion results different geoelectrical cross sections have been constructed. The shallow sand to sandy clay and the deeper limestone aquifers have been completely analyzed underneath and around the spring area. Promising new extension of As Sillein spring locality has been recommended. The interpretation emphasizes the importance of integrated geoelectrical surveying as a complementary or independent means of obtaining useful, cheap and fast lithological and structural subsurface information.

Keywords: geoectrical geophysics, ground water, egypt

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ASI011 **Oral Presentation** **3184**

Innovative applications of geosciences in support of natural resource management

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Geoscience Australia

Ken Lawrie

Australia possesses a range of complex natural environments and resources that have evolved over millions of years. These environments and resources, and the population centres that depend on them, are vulnerable to a range of natural geological hazards, and to global environmental changes. The geosciences are now being seen as underpinning holistic decision making for hazard mitigation (and recovery), and guiding infrastructure planning and investment strategies. Multi-disciplinary approaches - involving adaptations of technologies used in used in mineral exploration to characterise subsurface materials and processes - are leading to enhanced understanding of natural systems and human impacts. Strategic links between researchers and decision makers are leading to this information being applied to achieve better-informed and more effective land and water management. This presentation will illustrate a multi-disciplinary systems approach developed to map and characterise key biophysical components of the hydrogeological system critical to the movement of water and salts in the landscape, and to integrate spatial characterisation with studies of water and salinity dynamics. For example, integration of electromagnetic and radiometric data, digital elevations, and multispectral imagery have been used to enhance knowledge of the distribution of subsurface salinity and clay-rich acquicludes in the vicinity of Australia's largest river, the Murray. The results of these systems studies are being increasingly applied along the river for evaluating options for new irrigated agriculture schemes, managing saline groundwaters and protecting biodiversity. The approach can be adapted for a range of natural resource management and mineral exploration issues.

Keywords: effective decisions, natural resource management

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ASI011 **Poster presentation** **3185**

Examination of the Potential for Time Domain Electromagnetic Method for Monitoring water Infiltration to subsurface aquifer

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Recharge flux is one of the most difficult components of the water balance to measure. However, quantitative estimates of this flux are critical for water resource planning in semi-arid and arid areas. Geophysical methods that can be operated from the ground surface offer significant advantages for recharge monitoring. Specifically, because they do not require boreholes, they are typically inexpensive and can be used to monitor over large areas. Electrical and electromagnetic geophysical methods may be useful for monitoring recharge because of the dependence of both the electrical conductivity and the dielectric permittivity on the volumetric water content of a porous medium. However, it is unclear whether the pattern of water content change that occurs during recharge can be inferred, uniquely, from all geophysical responses. In this study, we examine the suitability of time domain electromagnetic (TEM) methods for monitoring infiltration into an initially dry soil. This preliminary examination is conducted as a sensitivity analysis in which we vary the porosity (P), initial water content (Wci) and the hydraulic conductivity (K) of the medium and calculate the TEM response with time during an infiltration event. Infiltration into a dry medium causes a large, localized change in the water content, making these conditions most conducive to recharge monitoring with geophysical methods. We consider this study to be a first-level examination of the potential for recharge monitoring with TEM. In order to examine the validity of the electric/electromagnetic methods as a monitoring tool for water infiltration, multiple geophysical surveys were conducted in the Tucson water recharge basins facility, Arizona, USA. The purpose of the geophysical investigation was to monitor water infiltration into the aquifer. This recharge basin provides controlled conditions for effective comparative-analysis of data yielded through hydrogeophysical field-based investigations where sensors can be deployed for extended time periods. Our geophysical investigation of the water recharge basin included time domain electromagnetic (TEM), frequency domain electromagnetic (FEM), electrical resistance tomography (ERT), controlled source audio magnetotellurics (CSAMT) methods. These surveys were designed to monitor field-scale water infiltration and drainage, and gather more detailed data on shallow and deep-water flow. The goal of this survey is to improve our understanding for the applications of the different electrical and electromagnetic techniques and to determine the limitations of each method for monitoring applications.

Keywords: infiltration, time lapse, electromagnetic

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ASI011 **Poster presentation** **3186**

Delineation of contamination plume around oxidation sewage-ponds in Southwestern Nigeria

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Integrated surface electrical resistivity and electromagnetic (EM) surveys were conducted in a hard-rock terrain of Southwestern Nigeria in the vicinity of active oxidation sewage treatment ponds. The aim was to detect soil contamination due to the spread of sewage effluent, locate possible leachate plumes and conductive lithologic layers, and access the risk of groundwater pollution in the vicinity of the sewage-ponds. Dipoledipole resistivity profiling and very low frequency (VLF) data were acquired at 10 m intervals along five 200-m long east-west geophysical traverses. Resistivity sections obtained revealed four subsurface geologic layers comprised of lateritic clay, clayey sand/sand, weathered/fractured bedrock, and competent bedrock. A distinct low resistivity zone corresponding to the contamination plume (labeled B) was delineated from all the resistivity sections. This low zone extends into the weathered bedrock and possibly suggests contamination of this layer. The filtered real component of the processed VLF data detected three distinct anomaly zones that are representative of fractured zones filled with conductive fluids and/or lithologic boundaries that possibly serve as conduits for the movement of contaminated effluents. The results obtained from the two methods suggest possible contamination of the subsurface soil layers and groundwater in the vicinity of the sewage-ponds. The existence of this contaminated plume poses a serious threat to the ecosystem and health of the people living in the vicinity of the sewage-ponds.

Keywords: sewage, dipole dipole, vlf

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ASI011 **Poster presentation** **3187**

Model tank DC-Resistivity characterization of LNALP migration in a Clayey-Sand Formation

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A modeling tank time-lapse 2D electrical resistivity experiment was undertaken to model the leakage of petroleum products from underground pipelines into a clayey-sand aquifer. Numerical modeling was employed to simulate the electrode arrays that would resolve the post-leakage subsurface image most efficiently. Of the four arrays tested, the dipole-dipole array proved most effective and was adopted for the laboratory studies. Pre-injection surveys were conducted to assist in discriminating between features caused by hydrocarbon accumulation and those due to natural geologic variability. Subsequently, controlled injection of diesel-oil into the model tank was undertaken at regular intervals over a period of 3 days. Experimental evidence obtained from the studies indicates that high resistivity build up few hours after injection is directly related to hydrocarbon accumulation. Rather than biodegradation of the hydrocarbon, a more probable explanation for the observed decrease in resistivity observed a few hours after injection is simply that the hydrocarbons drained to a deeper level after pooling temporarily at a shallow level.

Keywords: time lapse, resistivity, hydrocarbon

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ASI011 **Poster presentation** **3188**

Geoelectric investigation of a pluridirectional fissure system in a karstic area

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Laszl Szarka, Mihaly Varga

Numerous publications are known about a direct geophysical investigation of unidirectional fissure systems, but there have been no reports about the problem of pluridirectional fissure systems. The few surface geophysical methods, which could be potentially used for this purpose, have numerous, probably unresolvable difficulties. In this paper we present an attempt to map the pluridirectional fissure system in a buried limestone surface by combining geoelectrical profiling and geoelectrical azimuthal measurements. Results received by using both the so-called null-, and traditional arrays were jointly interpreted. In case of profiling the null array was used only to verify the traditional array results, while in the azimuthal measurements the null array plays a basic role in the interpretation. The humidity of the fissures affects the measured results significantly, and in a meaningful way.

Keywords: fissure, pluridirectional, geoelectrical

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ASI011 **Poster presentation** **3189**

New evidences of leachate plumes detected by a geoelectric studies at a waste disposal site and its environment in Gualeguach city, Province of Entre Ros, Argentina

Dr. Cristina Pomposiello
CONICET IAGA

Dapea Cristina, Favetto Alicia

Sanitary landfilling is the most common way to eliminate solid urban wastes. An important problem associated to this practice is the leachate production and the related groundwater contamination. The leachate electrical conductivity is often so much higher than natural groundwater, consequently a large contrast in this property is seen which enables the plume to be detected using these methods. This works reports new data obtained from two landfills of different age located in Gualeguaych city, Entre Ros province, Argentina. Several geoelectric studies, horizontal profiling and vertical sounding using dipole-dipole and Shlumberger electrode configurations were done. Important conductivity anomalies have been detected below the waste disposal. The 2D model obtained within the landfill shows a first layer with a thickness of (2 - 3) m and a resistivity range from 100 to 1000 ohm-m. The second layer has a thickness of (4 5) m and a low value of resistivity (3 to 6 ohm-m), which is attributed to the contaminated zone. The third layer has a thickness of more than 10 m and a resistivity of 15 ohm-m. Below this depth is observed another conductive layer (5 ohm-m). The 2D model obtained outside the landfill boundary presents a conductive layer at the same level of the inside one and its shows that contamination exists at the border of the waste disposal. These results agree with the value of the specific conductivity determined in the monitor phreatimeters.

Keywords: landfill, environmental geophysics, resistivity model

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ASI011 **Poster presentation** **3190**

Effects of lightning impact on organic matter-rich soil (São Miguel Island, Azores archipelago)

Dr. Vittorio Zanon

Teresa Ferreira, Fátima Viveiros, Catarina Silva, Ana Rita Hipólito

A detailed study was carried out on a single piece of land that had been affected by the impact with a thunderbolt during a violent rain-storm, with thunders and lightning that beat the Island of So Miguel, in the Azores Archipelago, in late October 2006. Temperature and gas measurements (CO2, CO, H2S and CH4) were performed in four study trenches, dug in an area of ~3 m2, where soil combustion was going on following one stroke of lightning, with the emission of a column of vapour and smoke. The soil under study was a well-pedogenized about 80 cm-thick layer, made of volcanic sandy tephra fallouts (Md = 1.05 = 2.23) and contained 5.5% of organic matter. The combustion was monitored during one week and revealed a peak release of 404 ppm CO and 3.4% CO2 originating from a layer located at a depth of about 50 cm. Measurements of temperature gave maximum values of 326 C inside the soil and 516.5 C on the surface of a lava block buried at a depth of about 20 cm obtained one week after the impact. It was also observed that the combustion area migrated slightly toward SW during the observation period. The stratigraphic study of the same area showed that immediately under the surface there was an about 40 cm-thick layer of oxidized combusted soil and also a great amount of roots and scorched wooden material were present. Under this more superficial layer there was an about 55 cm-thick soil portion that continued to burn almost in the absence of oxygen due to the presence of up to 19.6% of organic material and of peat deposit, producing a grey-to-white ash without char. The combustion process went on for about ten days, in spite of several other intense rain storms, until it was artificially extinguished through the excavations made to obtain study trenches. This particular circumstance enlightened even more the potential natural hazard represented by this kind of atmospheric event and the matter was, therefore, studied in detail and discussed.

Keywords: lightning, soilcombustion, grainsize

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ASI011 **Poster presentation** **3191**

The role of geophysical techniques for hydrogeological and environmental study in the Sand-Dunes area in Vietnam

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The study area is located in the south of the central part of Vietnam where extensive red-sand coastal dunes occur. The area between 1100000 -1100500 N and 10801500 - 10802500 E is the driest region of Vietnam. This area consists mostly of hills and coastal plains with variable relief from west to east. Geological units of the coastal sand-dune area (study area) are mainly Pleistocene sediments, consisting of marine-aeolian, alluvial-marine and marine sediments. Underlying Quaternary and Neogene sediments are hard rocks of igneous and metamorphic origins like dacite-ryodacite with very low permeability which can't be considered as likely aquifers. The aim of geophysical investigations is the appraisal of hydrogeological conditions for groundwater aquifer location in this area. The magnetotelluric soundings and magnetic prospecting are used for regional geological structure studying and complex geophysical techniques are selected for local geological structure as well as electric resistivity by vertical electrical soundings (VES), electrical profiling (EP), very low frequency (VLF), Georadar and seismic refraction. Because of very dry sand at the surface of the study area, then the best of geoelectrical data should be collected during the rainy season. There was useful time for measurement of contacting electrods. Georadar was used for around mountain for investigating of shallow bedrock. VLF was used for locating conductivity zones (saturated or moisty sands). The interface of deep bedrock is interpreted by seismic refraction data where the seismic velocity is higher then 3000 m/sec. The aquifer is located with the thickness in the range 20-50m and the depth to the bottom of aquifer is in the range 60-120m by seismic refraction and VES data. The results of geophysical techniques are proved by two monitoring wells with the depths of 63 and 71m and by two testing wells with the depths of 95 and 110m.

Keywords: geophysicaltechniques

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ASI011 **Poster presentation** **3192**

1D and 2D interpretation of the MT data to detect subsurface salinity and conductive structures in Inche-broon, Golestan, Iran.

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The electrical conductivity of upper few kilometers of the Earths upper crust is controlled by many parameters such as salinity of the subsurface structures. Very conductive Iodine structures are one of the subsurface salinity structures which can be formed at upper few hundred of kilometers of the crust. Thus, to study those kinds of structures, magnetotelluric (MT) is the most effective technique. Inche-broon plain is located in the northern Iran. In Feb-March 2006, an MT survey was conducted in the area. Data were collected along four east west profiles (37 sites in total). Sites distances are 1 km and profiles distances are 1.5 km. Subsurface electrical resistivity was verified by the information from a borehole in the vicinity of the area. Time series measurements collected in various frequency ranges are transformed into frequency domain, and cross power spectra are computed to estimate the impedance tensor as a function of frequency. Using determinant of impedance tensor called effective impedance, determinant apparent resistivities and phases are computed as inputs of inversion programs. The advantage of using the determinant data is that no mode identifications are required and static shift corrections are not made. When Swifts skews, that indicate the dimensionality, are below 0.2, the structures can be considered as undistorted 1D or 2D; otherwise, they are defined as distorted 1D and 2D structures or 3D structures. Dimensionality analysis of the MT data of the area shows that the assumption of undistorted 1D and 2D structures is correct. Processing of the data was carried out using Smirnovs (2003) approach. For 1D and 2D inversion, codes from Pedersen (2004) and Siripunvaraporn and Egbert (2000) were used, respectively. 1D and 2D models of the MT data across the profiles, considerably express conductivity of the area which illustrates the MT advantage compared with other electromagnetic (EM) methods that arent able to penetrate to high depths in the same areas. Resistivity model shows the presence of two very conductive layers in the area. These layers are attributed to layers consist of salt water (and probably Iodine minerals). These two layers are estimated in depths from 90m to 190m and from 250m to 650m, respectively and thicknesses from 5m to 30m for the first layer and from 10m to 120m for the second layer.

Keywords: magnetotelluric, inche boroon, resistivity

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ASI011 **Poster presentation** **3193**

Electroseismic wave simulation generated from a seismic pulse in a two-layer medium

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Mechanical and electromagnetic perturbations will be coupled in a porous medium saturated with liquid. This coupling is such that, while a seismic wave propagating through the mentioned medium will cause a relative movement between the solid and liquid. Then this movement will induce an electrical flux. When a seismic pulse propagates through a medium with a specific chemical and elastic properties shall cause an unbalanced in the electrical flux. The unbalancing in electrical charge will separates the dipoles and multi-poles at the both sides of an interface and that make it possible to record the electromagnetic perturbations at the earths surface. In this paper, electroseismic wave propagation have been studied and simulated in a layered and porous medium saturated with liquid. For this purpose the governing equations of Pride (1994) and the coupled equations of the Biot and Maxwell was used. To calculate the electroseismic traces, the generalized reflection and transmission matrix method was applied.

Keywords: seismoelectric, simulation, electromagneticperturbations

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ASI011 **Poster presentation** **3194**

Inversion of magnetotelluric data to detect Iodine bearing structures

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The electrical conductivity of upper few kilometers of the Earths crust is controlled by many parameters such as salinity of the subsurface structures. Iodine bearing structures are one of the subsurface salinity structures which can be studied using magnetotelluric (MT) which is the most effective technique in this field of exploration. Dashli-boroon area is located in the northern . In February. 2007, MT data were collected at 57 stations along 8 eastwest profiles. MT Sites were located with 2 Km distances. Using the determinant of the impedance tensor, apparent resistivities and phases were computed as inputs of inversion programs. The advantage of using the determinant data is that no mode identifications are required and static shift corrections are not made. Dimensionality analysis of the MT data of the area shows that the assumption of undistorted 1D and 2D structures is valid. Processing of the data was carried out using Smirnovs (2003) approach. For 1D and 2D inversion, codes from Pedersen (2004) and Siripunvaraporn and Egbert (2000) were used, respectively. 1D and 2D models of the MT data across the profiles, considerably express conductivity of the area which illustrates the MT advantage compared with other electromagnetic (EM) methods that arent able to penetrate to high depths in such conductive areas. Resistivity models show a very conductive layer in the area. This layer is attributed to layers consist of saline water probably including Iodine minerals.

Keywords: magnetotelluric, inversion, dashli boroon

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ASI011 **Poster presentation** **3195**

Audiomagnetotellurics investigations of railway tunnel route

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Investigations of geological structure along lines of railways tunnels with allocation of fault and fissuring zones, study of their structure and estimation of degree of water saturation have a large importance for their successful construction and subsequent exploitation. At the solution of the tasks electromagnetic sounding methods can be used, allowing study geoelectrical cross sections along tunnels using differentiation of rocks on electrical resistivity. Experience of application of electromagnetic methods shows that monolithic blocks of rocks are usually allocated by increased resistivity values and zones of faults and fissuring are usually water saturated and marked by lowered resistivity values.In the abstract results of the audiomagnetotelluric (AMT) sounding method along the line of construction of the high-speed railway Madrid Vayadolid are considered. The area of investigation is San-Pedro hills with metamorphic rocks and granitoids, where the tunnel consisting of two lines at the depths from 20 up to 250 m and the length of about 6 km is constructing. The AMT method is based on the study of natural electromagnetic fields in the audio frequency range from the first hertz up to first kilohertz. The modern AMT system ACF-4M realizes the high accuracy of measurements (1 % for apparent resistivity and 0.5 deg. for impedance phase). Investigations by the AMT method were carried out along the San-Pedro tunnel route with distance between sounding points of 50 m. Interpretation of apparent resistivity and impedance phase curves was carried out using a 2D inversion program and the geoelectrical cross section up to the depth of 600 m was obtained. The AMT data show that by low resistivity values, less then 300 Ohmm, are marked broken and water saturated rocks. Values of resistivity of 300-1000 Ohmm are typical to broken rocks, and high values of resistivity more then 1000 Ohmm to monolithic rocks. According to the specified values of resistivity rocks of "bad", "acceptable" and "good" quality from the point of view of conditions for the tunnel construction were allocated.Results of the AMT method are correlated both with data of geological investigations obtained at previous stages of work and with results of previous drilling. At the same time on the AMT data a number of additional conducting zones, appropriated to faults, missed at previous stages were allocated. The AMT data have allowed receive essentially new information on structure of the area of the San-Pedro tunnel.

Keywords: audiomagnetotellurics, tunnel, rocks quality

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ASI011 **Poster presentation** **3196**

The spatial distribution of the electromagnetic fields surrounding L'Aquila (Italy) due to a new electrified public transport

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Cinzia Di Lorenzo, Fabrizio Masci

The MEM Project (Interreg IIIA Adriatic Cross Border Programme) has been activated in the INGV (Italian Istituto Nazionale di Geofisica e Vulcanologia) Observatory of LAquila since 2004. The leader partner of the project is the Abruzzo Region. The others Italian partners are the INGV Observatory of LAquila, the Regional Environmental Agency of Molise and the University of Ferrara, while the European partners are theUniversity of Tirana and the Geomagnetic Institute of Grocka, Beograd. One of the purposes of the MEM project is the monitoring of the electromagnetic environmental noise. A new urban electrified public transportation system will be activated in LAquilaat the end of 2007. The electromagnetic emissions generated by the electric lines network whenever an electric transient is present on the power system as the trolley cars move is modelled by means of horizontally antenna elements approximation. The results will be expressed by the spatial distribution of the electric and magnetic field strength and the energy density in different frequency ranges.

Keywords: electromagnetic, emissions

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ASI011 **Poster presentation** **3197**

Electromagnetic fields measurements in ULF-ELF-VLF (0.001Hz-100KHz) bands

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Cinzia Di Lorenzo, Fabrizio Masci

The MEM Project (Interreg IIIA Adriatic Cross Border Programme) has been activated in LAquila since 2004 with the purpose to monitoring the environmental electromagnetic signals in ULF-ELF-VLF (0.001 Hz-100 KHz) bands. The leader partner of the project is the Abruzzo Region. Data from interferometric array will allow to realize environmental electromagnetic tomography in order to obtain a graphical representation of the electromagnetic fields in the domain of time, frequency and space. This technique is a good investigation tool to obtain three-dimensional maps of electromagnetic background noise, on regional scale. Tomographic maps are useful to show the spatial distribution of electromagnetic sources and to characterize signals with a set of parameters such as energy, polarization, spectral content and so on. Data from each station will be elaborated to investigate different sectors as the structure of ground electric conductibility, the electromagnetic phenomena connected with tectonic processes, the separation of electromagnetic fields of internal origin to the Earth and the electromagnetic phenomena originated in the magnetosphere, in the ionosphere and in the Earth-Ionosphere cavity. Here we are reporting some results obtained in the first station of the interferometric array. The station was installed near the INGV Geomagnetic Observatory of LAquila (42 23 N, 13 19E, 682m a.s.l.) since the middle of 2005.

Keywords: ulf, elf, vlf

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ASI011 **Poster presentation** **3198**

Electrical Resistivity Tomography applied to a feedlot to detect conductivity anomalies

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Malleville Horacio, Losinno Beatriz

The intensive animal production is considered highly risky for groundwater and soil. Animal wastes over sites of high stocking rate or the seepage from waste lagoons are point sources of contamination especially by nitrates, chlorides, or heavy metals which may be also transferred, through groundwater movement to the discharge zones. It is important to improve management practices to insure sustainability of the activity. This work is part of a project focused to apply electrical resistivity methods to detect contamination by animal wastes and make comparison between different types of management. Previous works at dairies showed critical situations at feeding zone and effluents lagoons.The aim of this work was to obtain an electrical conductivity image of unsaturated and saturated zone at a feedlot (cattle feeding field) at the surroundings of Buenos Aires city (Argentina) in order to detect the most critical sectors of the field. Silty loamy soils characterize the zone with a clay horizon at 30 cm depth and concretions of calcareous. Dipole-dipole electrical soundings (electrical resistivity tomography) with electrode spacing of 2m, with a maximum profile distance of 100 m were performed at the corral zone and the surroundings. A 3D model of conductivity was obtained with the UBCGIF software. Even if there is a calcareous plate bellow the corral soils, vertical infiltration or subsurface runoff may have occurred since these sites show conductivities three times higher than the surroundings (greater than 0.1 S/m) up to a depth of 5-6 m, particularly near a small channel of effluents. The 3D model showed higher conductivities in the direction of groundwater flow and decreasing topography, allowing a better design of soil sampling and further infiltration experiments.

Keywords: electrical conductivity, contamination, feedlot

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ASI011 **Poster presentation** **3199**

Very low frequency electromagnetic observations in the high altitude region of North Sikkim, India

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K. Anbarasu, Saibal Gutpa, A. Sengupta

Landslides are very common in the high altitude Himalayan territory. Major roads in Himalaya often get blocked due to heavy landslide and remain closed for long time. Lantakhola is one of the oldest landslides in north highway which is active since long time. Rock types on either sides of the landslide are different and it is believed that MCT is passing through this landslide. Permanent solutions of these landslides are required to keep the highway open. Delineation of subsurface structures below the landslide is very important to arrive at a definite conclusion about how to avoid landslide. This can only be accomplished by geophysical survey. However, it is very difficult to find suitable ground over high slopes in these areas to carry out geophysical survey specially electrical and electromagnetic. Very low frequency electromagnetic survey is performed over Lantakhola landside in northern highway to depict the subsurface fracture/slipping zone through which landslide takes place. Even though very limited numbers of VLF transmitters are available worldwide, it was possible to pick up the VLF signal from a number of VLF station at this high altitude mountainous terrains. High conducting zones are delineated from VLF observations. This conducting zone is also correlated with the low resistive zone delineated using gradient resistivity profiling. These anomalies confirm that there is no stable ground up to a large depth below the Lantakhola slide. Therefore, Lantakhola slide will remain active in future. Slope study of the landslide over a five year interval reveals that slope is gradually increasing. Resistive structures depicted on either side of the landslide zone can be correlated with the stable ground. A bridge through these two locations could solve the Lantakhola problem permanently. However, such bridge will also vulnerable because it may hit by falling massive boulders.

Keywords: landslide, vlf method, high altitude

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ASI011 **Poster presentation** **3200**

Removal of near-surface effects in 2D Schlumberger resistivity for improved characterisation of covered landfill sites: a TEM-based approach

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Dr Max Meju

It is known that the presence of near-surface heterogeneities can cause electrical static shift which limits the predictive accuracy of linear dc resistivity surveying employing the Schlumberger array. This paper investigates the removal or minimisation of near-surface effects on Schlumbergerdc resistivity soundings in a landfill environment using collocated dc and TEM soundings. Initial joint analysis of Schlumberger and TEM sounding curves from two linear profiles at a landfill site provided dc sounding curves corrected for electrical static shift. Conventional two-dimensional (2D) smooth model inversion studies of the static shift corrected data and the uncorrected resistivity data (as in conventional practice) have been undertaken for comparison. The 2D results suggest that the resistivity models from the corrected datashow improved lateral continuity of resistivity structure and that the actual resistivity values also show improved correlation with the data furnished by alternative (horizontal-loop) electromagnetic and borehole hydrochemicalmeasurements.

Keywords: dc resistivity, landfill, characterisation

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ASII012 **3201 - 3217**

Symposium
Small- and meso-scale structure in the thermosphere and ionosphere: observations and modeling

Convener : Dr. Anasuya Aruliah
Co-Convener : Prof. David Hysell

Remarkable advances over recent years in CCD sensitivity and radar techniques are allowing thermosphere and ionosphere observations to resolve structures at ever-smaller spatial and temporal resolutions. Many techniques now achieve meso-scale resolutions of several 10's kilometers spatially and a few and minutes temporally, with resolutions of kilometers and seconds being possible in some cases. Numerical models are also beginning to explore these same resolutions, using techniques such as nested-grids. Meso-scale structure is most likely established by the highly dynamic interactions of the solar wind with the magnetosphere, ionosphere and thermosphere. For example, it is now thought that small scale variability may account for the discrepancy in the high-latitude energy budget by a factor of up to 2 between models and observations. Also, it is now possible to examine in detail the role of high-latitude electrodynamics in forcing phenomena such as waves, divergence, shear and vertical motion.

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ASII012 **Oral Presentation** **3201**

Optical illumination of sporadic-e layer irregularities by high power HF radio waves

Dr. Paul Bernhardt

Frank T. Djuth, Michael P. Sulzer, Craig A. Tepley

Sporadic-E irregularities at low- and mid-latitudes are not usually visible to low-light-level CCD cameras because there is no natural process for optical excitation of the plasma in the 90-120 km altitude range. Experiments in 1999 at the Arecibo Observatory in Puerto Rico have demonstrated that high power radio waves near 3-5 MHz can cause Sporadic-E layers to glow at the green-line (557.7 nm) emission of atomic oxygen. The excitation process involves coupling of the powerful HF waves that reflect in the ionosphere into electrostatic waves near the reflection altitude. The electrostatic waves have been remotely detected by the Arecibo 430 MHz radar with incoherent scatter from ion-acoustic waves to yield enhanced ion lines. Ion-acoustic waves and Langmuir waves are simultaneously produced by parametric decay of the electromagnetic pump. Electrons accelerated by the electrostatic Langmuir waves collide with atomic oxygen to produce green-line emissions which outline the Sporadic-E structures. In underdense regions, where the plasma density is too low to reflect the HF waves, the electrons are not accelerated and induced glow is absent. The HF induced optical emissions have produced images of the Sporadic-E layers with 1-10 km scale sizes and wave-like features. A new Arecibo HF facility is being funded by the US National Science Foundation, the Office of Naval Research, and the Air Force Office of Scientific Research. The new facility will use a -wavelength dipole at 5 MHz mounted over the Arecibo 600 m diameter dish. Transmitters that feed the dipole antenna will yield 100 to 200 MW effective radiated powers for excitation of Sporadic-E layer glow. The intensities of the glow structures should be greater than 100 Rayleighs. Ground CCD cameras will observe the E-layer plasma irregularities as they drift through the HF radio beam. Using this technique, the horizontal drift velocity and the irregular structures will be routinely measured with the updated Arecibo heating facility. Other HF facilities constructed near low-latitudes sites such as Jicamarca, Peru can be similarly used to measure km-scale irregularities in the E-region.

Keywords: plasma irregularities, e layer, ionospheric heating

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ASII012 **Oral Presentation** **3202**

Neutral density measurements in the polar thermosphere during the HEX-2 rocket campaign

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Lin Li, Miguel Larsen, John Craven, Mark Conde

The HEX-2 salvo was launched on February 14, 2007, at 09:22, 09:27, 09:36, and 09:38 UTC from Poker Flat Research Range, Alaska, comprising four sounding rockets to investigate mesoscale dynamics in the lower thermosphere that are triggered by auroral particle and Joule heating as well as ion-neutral momentum coupling. One payload was guided on a horizontal trajectory (H-1) with apogee of 150 km and three payloads were on vertical trajectories (V-1, V-2, V-3) with apogees of up to 206 km. All payloads carried TMA chemical release experiments to measure neutral winds. In addition, the H-rocket included a Langmuir probe and the V-rockets between them carried six cold-cathode ionization gauges (CCG) to measure neutral density variations. Prior to the launches, a surge in the solar wind speed and southward magnetic field led to sustained auroral activity and electrojet currents through the region above north-central Alaska. It was the first mission for the CCG instruments, which were developed as an uncomplicated and economical rocket-borne sensor. A total of twelve density profiles were obtained during the uplegs and downlegs of the V-rockets. First results from our analysis will be presented.

Keywords: polar thermosphere, neutral density

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ASII012 **Oral Presentation** **3203**

Effects of penetration electric fields on low latitude ionosphere

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EFFECTS OF PENETRATION ELECTRIC FIELDS ON LOW LATITUDE IONOSPHERE N. BALAN(1), H. Alleyne(1), S. V. Thampi(2), K. Lynn(3), B. G. Fejer(4), M. A. Abdu(5), K. Niranjan(6), R. S. Dabas(7), G. J. Bailey(8) (1)Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK. (2)SPL, VSSC, ISRO, Trivandrum, India. (3)Ionospheric Systems Research, Noosaville QLD 4566, Australia. (4)Utah State University, USA. (5)INPE, Brazil. (6)Department of Physics, Andhra University, India. (7)Radio Science Division, NPL, Delhi, India. (8)Applied Mathematics, University of Sheffield, UK. Abstract: The magnetospheric electric fields induced by CME (coronal mass ejection) clouds, when mapped to the high latitude ionosphere and penetrated to equatorial latitudes, are known to cause major changes in the low latitude ionosphere. In this paper, we study the effects of the penetrating (and disturbed dynamo) electric fields on the low latitude ionosphere using observations and modeling. The passage of two CME clouds during 07-08 November and 09-10 November 2004 produced a rare super double geomagnetic storm with three positive initial phases. The Jicamarca IS radar over the geomagnetic equator observed strong east-west electric fields during the storm; the strongest ever recorded penetration occurred on 09 November 2004. The low latitude F region ionosphere in Australian, Indian and American longitudes showed large depletions in electron density during period of penetrating eastward electric fields when an additional layer (F3 layer) around the equator quickly ascended to the topside ionosphere. During periods of strong westward electric fields, the F3 layer disappeared and the electron density around the equator increased. These ionospheric effects are modeled by incorporating the measured electric fields into the Sheffield University Plasmasphere Ionosphere Model (SUPIM). -- 1. Session Code: ASII012 2. Title : Small- and meso-scale structure in the thermosphere and ionosphere: observations and modeling 3. Key words: Ionospheric depletion, F3 layer 4. N. Balan, Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK Tel: 114-222-5234; Fax: 114-222-5661 E-mail: b.nanan@sheffield.ac.uk 5. Oral 6. PC 7. No 8. No

Keywords: ionospheric, depletion, f3layer

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ASII012 **Oral Presentation** **3204**

The fractal structure of convection in the thermosphere and ionosphere

Dr. Mervyn Freeman
Natural Complexity Programme British Antarctic Survey IAGA

We present and discuss the results of recent studies of the temporal and spatial structure of convection in the thermosphere and ionosphere measured by Fabry-Perot interferometers and radars, respectively, and analysed using structure functions. The structure of fluctuations in convection is revealed to be fractal over a wide range of scales in time and space but with different properties for the neutral and ionised fluids and in different geophysical regions. We discuss the possible reasons for this and how such results may be utilised to improve general circulation models of the atmosphere.

Keywords: convection, fractal

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ASII012 **Oral Presentation** **3205**

ISR observations of dayside convection and its coupling to ionospheric disturbance electrodynamics

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Shasha Zou, Craig Heinselman, Mary Mccready

We will describe a technique to use the Sondrestrom and Svalbard IS radars to monitor polar-cap convection near the dayside separatrix (open-closed field line boundary) and our finding that it can be used to monitor convection and its response to solar wind and IMF variations with 2.5-min time resolution. This technique should be able to provide input conditions for studies of ionospheric and thermospheric disturbances of various spatial scales. Of particular interest is the electrodynamics of auroral disturbances, such as substorms, dynamic pressure disturbances, and poleward boundary intensifications and their connection to the temporal evolution of the Harang electric field reversal and of dayside convection. With the new AMISR radar, we now have an unprecedented capability to evaluate this electrodynamics and its connections to dayside convection and the Harang reversal. We will describe our plan to use Poker Flat AMISR observations to evaluate disturbance electrodynamics, and to relate this electrodynamics to the formation and decay of the Harang reversal and to the strength of dayside and polar-cap convection.

Keywords: convection, is radars, coupling

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ASII012 **Oral Presentation** **3206**

Simulation of shock reformation physics and electron energisation at collisionless shocks

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Peter A. Robinson

Numerical simulations have revealed a strongly nonstationary behavior for shock waves with parameters relevant in heliospheric and astrophysical contexts. This behavior is characterized by cyclical reformation on the spatio-temporal scales of the upstream ion gyroperiod and convected ion gyroradius. In this paper we study, first, the dynamics of low plasma beta ($beta=0.05$), high Alfv'{e}n Mach number ($M_{A}=4sim 5$), quasi-perpendicular ($theta_{bn}=87 ^{circ}$) collisionless shocks and, second, the production of burst of energetic electrons by the time-dependent reforming shocks self-consistently generated by an one-dimensional hybrid code. We show that the additional electron dissipation in the extended hybrid simulations leads to a strong ion thermalization and phase space mixing between upstream incoming and reflected ions via plasma wave interactions in the foot, and formation of ion phase space holes. Two plasma wave populations are observed in the foot, and ramp region. Whistler waves, mostly in the foot and ramp regions, have typical wavelengths and frequencies of $0.3v_{A}Omega_{ci}^{-1}$ and $16Omega_{ci}^{-1}$, respectively, cause strong mixing between upstream incoming and reflected ions that corresponds to strong ion heating. Lower hybrid waves extend throughout the foot and downstream region, and are not effective in heating ions. By using test particle calculations in the electromagnetic fields of reforming shocks (produced by the standard hybrid simulation), we show that bursts of energetic electrons are released into upstream region. The bursts cyclically occur at the shock reformation period and are qualitatively very different from the continuous beam expected for a time-stationary shock.

Keywords: collisionlessshocks, electronacceleration, hybridsimulations

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ASII012 **Oral Presentation** **3207**

Enhanced Aurora and Instabilities in Thin Ionization Layers

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Hideo Okuda

Nearly half of the time, natural auroral displays exhibit thin (~1 km), bright layers known as "enhanced aurora." There is a substantial body of evidence that connects these optical displays with an enhancement of the background electron density detected by incoherent scatter radar around the same altitude in the E-region. The electron enhancement is related to an accumulation of heavy Fe and Mg into thin layers, which occurs for specific orientation fo the ionospheric electric field. Based on the spectral characteristics of the emission in the enhanced layers, it is believed that the enhanced emissions result when wave-particle interactions heat ambient electrons to energies at or above the 17 eV ionization energy of N_2. We investigate instabilities that occur in dense, heavy ion layers in the presence of strong cross-field currents that accompany electron precipitation. We examine global eigenvalue solutions of the instability including ionospheric collisions and kinetic effects which both play a role in localizing the instability to the thin layer region. In the nonlinear stage, the instability can heat ambient electrons into a suprathermal tail which we examine using a full-particle electrostatic simulations. Such electrons could produce the enhanced emissions observed in the aurora.

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ASII012 **Oral Presentation** **3208**

Radar and optical observation of medium-scale traveling ionospheric disturbances and field-aligned irregularities in the F region

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Tadahiko Ogawa, Tatsuhiro Yokoyama, Kazuo Shiokawa, Mamoru Yamamoto

We report for the first time simultaneous observations of Medium-Scale Traveling Ionospheric Disturbances (MSTIDs) and Field-Aligned Irregularities (FAIs) in the F regionusing two all-sky airglow imagers and the MU radar. The all-sky imagers were operated at Sakata (39.0N, 139.9E) and Shigaraki (34.9N, 136.1E), Japan. MSTID propagating southwestward was simultaneously observed in 630-nm airglow images at the bothsites. To investigate spatial relationship between MSTID and FAIs,FAIs were mapped onto the 630-nm airglow layer (260 km altitude). Altitude of the airglow layer was estimated by the triangulation using all-sky images at Sata and Shigaraki. FAIs with strong echo intensity and upward Doppler velocities coincided with the airglow depleted region due to the MSTIDs. On the other hand, FAIs with weak echo intensity and downward Doppler velocities coincided with the airglow enhancement. The directions of the Doppler velocitiesis consistent with that of ExB drifts caused by the polarizationelectric fields associated with the MSTIDs. A model calculation was carried out to simulate electron density perturbations caused by oscillating electric fields due to MSTIDs. The result suggests that FAIs could be generated by the gradient drift instability which operates at thespatial gradient of the electron density associated with the MSTIDs.

Keywords: airglow, radar, tid

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ASII012 **Oral Presentation** **3209**

Effects of high-latitude ionospheric electric field variability on the estimation of global thermospheric Joule heating

Dr. Tomoko Matsuo
IAGA

Arthur D. Richmond

One of the outstanding problems in modeling of the magnetosphere-ionosphere-thermosphere system is the quantitative bias systematically seen in simulated thermosphere and ionosphere responses to magnetospheric forcing. This systematic bias is considered to be attributed largely to insufficient Joule heating when the ionosphere-thermosphere models are driven by climatological models of ionospheric convection. In this study, effects of high-latitude ionospheric electric field variability on the estimation of Joule heating are investigated by incorporatingthe spatial and temporal characteristics of electric field variability derived from observations into the forcing of a thermosphere-ionosphere-electrodynamic general circulation model (TIEGCM). First, the characteristics of sub-grid scale variability have been examined from a spectral analysis of Dynamic Explorer-2 (DE-2) plasma drift measurements. The analysis reveals that the sub-grid scale electric field varies with magnetic-latitude, magnetic-local-time, interplanetary magnetic field, and season in a manner distinct from that of the resolved-scale electric field and of the climatological electric field. Second, the spatial-temporal structure of resolved-scale electric fields are characterized from various electromagnetic observations taken during the storm period of January 10-11, 1997, using a space-time separable covariance model derived from the DE-2 observations. Finally, the modeling results show that the estimated amount of Joule heating in the thermosphere is significantly altered by taking into account the electric field variability and its space-time structure.

Keywords: joule heating, electric field, variability

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ASII012 **Oral Presentation** **3210**

Rocket observations of the response of the E-region neutral winds to auroral forcing: recent results and an overview of results from earlier experiments at Poker Flat, Alaska

Prof. Miguel Larsen
Dept of Physics Clemson University

Although the number of measurements is limited, sounding rockets have provided some of the most detailed neutral wind profile measurements in the high-latitude E region. The talk will present results from recent measurements made at Poker Flat, Alaska, that show the variations of the winds both with altitude and latitude during disturbed conditions. The more recent wind measurements will also be compared with earlier similar measurements from Poker Flat and other high-latitude locations. The observations show significant variations in the wind fields over horizontal separations of 100 to 200 km, and a strong response of the winds in the E region to auroral forcing. The forcing responsible for the neutral winds will also be discussed, including the contribution of small-scale variations in the electric fields to the overall Joule heating rate.

Keywords: neutral winds, auroral oval, e region

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ASII012 **Oral Presentation** **3211**

First Light from the Tristatic Alaskan Fabry-Perot Interferometer Network

Mr. Russell Hedden
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John Meriwether, Michael Faivre, Miguel Larsen, Don Hampton

An important issue in polar studies of thermospheric dynamics is the question of ion-neutral coupling by which plasma convection transfers momentum to the background neutral atmosphere. A new Fabry-Perot observatory network has been established in central Alaska at the three sites of Poker (65.117 N, 147.143 W), Fort Yukon (66.568 N, 145.256 W), and Eagle (64.786 N, 141.200 W)that observes the Doppler shift and Doppler width of the 630-nm airglow or auroral emisson. The purpose of these measurements is to achieve tristatic measurements of thermospheric wind vectors at four common volume points that overlap with the AMISR observations of plasma convection speeds and ion temperatures. Additional Fabry-Perot measurements of zonal and meridional winds are also obtained for each site. These observations permit the calculation of the divergence and vorticity through the application of Stokes theorem. The variation of the ratio of divergence to vorticity is sensitive to the extent and importance of Joule heating. First results from January 2007 show exposure times of 120 s produce results of 2-5 m/s and 10-15 K uncertainties for the Doppler shift and Doppler width, respectively, for active times when the 630-nm intensity is 1-2 kR. Quiet times with intensities of 100--200 R show results of 7-10 m/s and 25-30 K uncertainties for the same exposure time of 120 s.

Keywords: polar thermospehric dynamics, ion neutral coupling, tristatic fpi

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ASII012 **Oral Presentation** **3212**

Imaging observation of mid-latitude ionospheric irregularities by MU radar ultra-multi-channel system

Dr. Susumu Saito
IAGA

Mamoru Yamamoto, Hiroyuki Hashiguti, Tadahiko Ogawa

With the middle-and-upper atmosphere (MU) radar ultra-multi-channel system, mid-latitude E and F regions field-aligned irregularities (FAIs) were observed with the radar imaging technique. Fine-scale structures of quasi-periodic (QP) echoes associated with the sporadic E (Es) layer, type-1 radar echoes in the E region, and F region FAIs associated with mid-latitude nighttime spread F were studied. QP echoes often have narrow (1 km width or less) band structures elongated from northwest to southwest. F region FAIs were observed associated with medium-scale travelling ionospheric disturbances (MSTIDs). Small scale structures (less than 10 km) embedded in MSTIDs were found. They drifted along the wave fronts of MSTIDs at velocities that were consistent with Doppler velocities. At the meeting, mechanisms generating those irregularities including coupling processes between the E and F regions will be discussed.

Keywords: midlatitude ionosphere, mu radar, radar imaging

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ASII012 **Oral Presentation** **3213**

Meso-scale studies of the response time of the polar cap thermosphere

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Eoghan Griffin, Ian Mcwhirter, Andrew Charalambous, H.-C. Iris Yiu

A new Scanning Doppler Imager has been installed at the Nordlysstasjonen at Longyearbyen, Svalbard (78 N, 15 E) in December 2006. The SCANDI is an all-sky Fabry-Perot Interferometer which allows observation of the 630nm auroral and airglow emission, and consequently measurement of neutral winds and temperatures at an altitude of around 240km. The field-of-view has a radius of around 600km and overlaps the fields-of-view of the EISCAT Svalbard Radar and SPEAR radar. It will now be possible to measure ion-neutral coupling behaviour on scales of 10s of kilometres with a temporal resolution of a few minutes. This paper will present the first results of an investigation into the response time of the thermosphere to ionospheric forcing.

Keywords: thermosphere, ionosphere, meso scale

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ASII012 **Oral Presentation** **3214**

Unusual thermospheric wave structures observed in the all-sky OI 630 NM emission images over brazilian low latitudes sector

Dr. Alexandre Pimenta
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Using ground-based measurements we investigate the unusual observations of moving dark wide-band structures in the OI 630 nm nightglow emission all-sky images that occurred in the Brazilian low latitudes region. On the nights of August 30-31, 1995, July 19, 1998 and July 13, 1999, the all-sky imaging observations of the OI 630 nm emission carried out at Cachoeira Paulista (22.7S, 45W, magnetic declination 20W), Brazil, showed dark band structures, stretched across the entire imager, propagating from southeast to northwest. These dark patches moved with average speed of about 200 m/s at an altitude of 220-300 km, which is the typical altitude range of the OI 630.0 nm airglow emission. Also, ionosonde observations, available for two of the events, registered abrupt increases in both the F-layer peak height (hpF2) and base height (hF) on July 19, 1998 and July 13,1999, when the low intensity band passed over Cachoeira Paulista. It should be pointed out that these thermospheric events are not related to geomagnetic disturbed conditions. In this paper we present, for the first time in the Brazilian sector, events of wide-band structures and the effects of the ionization on its propagation in the nighttime ionosphere.

Keywords: thermosphere, ionosphere, airglow

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ASII012 **Oral Presentation** **3215**

Observations of the extended thermospheric temperature field over Svalbard

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A. L. Aruliah, I. Mcwhirter, A. Charalambous, H.-C. I Yiu

Measurements of all-sky thermospheric neutral temperatures from observations of the 630nm oxygen red line have been obtained using a new instrument called SCANDI (for Scanning Doppler Imager) which was installed in the Nordlysstasjonen at Longyearbyen, Svalbard (78oN, 15oE) in December 2006. The location allows extensive comparison to existing optical instrumentation, including an existing standard Fabry PerotInterferometer which also observes the 630 nm emission. The temperature results are compared both to this FPI and to the ionospheric temperatures and velocities measured by the colocated Eiscat SvalbardRadar (ESR). Results are also combined with the observations of ionospheric velocities provided within the CUTLASS radar fields of view. With this unique arrangement of complementary instrumentation the structureobserved in the extended field of thermospheric temperatures (around 1200 km diameter) is examined and the implications for further studies of the coupled ionosphere-thermosphere system is discussed.

Keywords: thermosphere, temperature, fabry perot

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ASII012 **Oral Presentation** **3216**

Three-Dimensional Simulation of Midlatitude Ionospheric Irregularities in Coupled E and F Regions

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Yuichi Otsuka, Tadahiko Ogawa

Since the discovery of turbulent upwelling associated with midlatitude spread F with the MU radar, midlatitude ionosphere has been intensively studied for the last two decades. Two-dimensional airglow images or GPS-TEC maps have revealed that banded structures, or medium-scale traveling ionospheric disturbances (TIDs) frequently occur in the nighttime midlatitude ionosphere. Although it is accepted that the Perkins instability is the most likely mechanism to explain the TID structures, the rapid growth and the southwestward propagation of the TID cannot be derived from the linear theory of the Perkins instability. Recently, it is proposed that the coupled electrodynamics between the E and F regions plays an important role in the growth of the Perkins instability. For the purpose of studying the coupled electrodynamics, we have employed three-dimensional numerical model which covers altitudes from 90 km to about 500 km. Growth of the Perkins instability is successfully reproduced with this model in the typical nighttime condition, while the instability does not grow under the condition that a uniform sporadic-E (Es) layer exists in the coupled E region. On the other hand, the polarization electric field generated in a modulated Es layer can map up to the F region and effectively seed the Perkins instability. The coupled electrodynamics is essential for understanding the phenomena in the midlatitude E and F regions.

Keywords: perkins instability, modeling, coupling

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ASII012 **Oral Presentation** **3217**

Survey of small-scale auroral structures in ASK multispectral images

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H. Dahlgren, G. Marklund, M. Ashrafi, B. S. Lanchester, J. M. Sullivan, D. K. Whiter

A morphological survey of the small-scale structure observed by the ASK (Auroral Structure and Kinetics) instrument is presented. ASK is a set of three narrow field of view cameras, each operating with a narrow passband filter to select different auroral emissions. During the winter season of 2006/7 the instrument was deployed at the EISCAT Tromso site. Pointing into the magnetic zenith, ASK with its 3 degree field of view (corresponding to 5 km at 100 km altitude), sub-second integration times and various combination of the observed emissions (N2 PG, N2+ 1N, OI 7774, [OII] 7320, O2+ 1N) provides a unique dataset for studies of auroral structuring. Typical morphologies of the auroral structuring on kilometer and subkilometer scale are surveyed, compared to the spectral properties of the aurora (indicative of the energies of the precipitating electrons). The results are discussed in terms of the possible physical auroral acceleration mechanisms.

Keywords: small scale structure, ask, physical auroral acceleration

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ASII013 **3218 - 3223**

Symposium
Response of the ionosphere-thermosphere to large geomagnetic storms: data availability and modeling

Convener : Prof. Alan Aylward
Co-Convener : Prof. Lie Zhu, Dr. Balan Nanan

Global Circulation Models (GCMs) of the terrestrial thermosphere predict fairly accurately the diurnal, seasonal and solar cycle variability of the thermospheric temperature and winds. However, in dynamic situations, though the individual elements of behaviour seen can generally be explained, the balance between them, their timing and their relative magnitudes are still difficult to predict. During extreme storms, the sort that occur only a handful of times a year, the behaviour is particularly complex, and understanding and predicting the flow of events for such circumstances will be the ultimate test of our understanding of the physics. This is solar-terrestrial coupling - Space Weather - at its limit. New space missions and improved ground-based facilities are providing new data for studying these events, and the resolution and complexity of GCMs is being continually improved to keep up with the volume and resolution of the data. How far we have come in measuring, understanding and simulating the more extreme events is the topic of this session. Some of the work presented is expected to form an argument for more directed ground-based experiments and space missions.

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ASII013 **Oral Presentation** **3218**

The effect of intense interplanetary electric fields during super magnetic storms: the dayside ionospheric superfountain effect

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Olga P. Verkhoglyadova, Anthony J. Mannucci, Akinori Saito, Tohru Araki, Toshitaka Tsuda

Interplanetary electric fields penetrate to the dayside equatorial ionosphere during magnetic storms. The ionospheric electric fields lift up the dayside ionosphere creating a superfountain effect. Some of the consequences are: uplift of electrons and ions to higher altitudes and absolute latitudes, transport of plasmas from the equator to middle latitudes, and increases in the total electron content (TEC) and ion content of the dayside ionosphere. Ion-neutral drag leads to the consequence of neutral oxygen uplift which may cause significant low altitude satellite deceleration.

Keywords: superstorm, superfountain, ionosphere

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ASII013 **Oral Presentation** **3219**

Thermosphere Response to the May 29, 2003, Magnetic Storm as Observed by CHAMP and GRACE

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J.M. Forbes

Accelerometers on the CHAMP and GRACE satellites have made it possible to accumulate near-continuous simultaneous records of thermosphere density between about 380 and 500 km since March, 2002, and have recorded the response to virtually every significant geomagnetic storm during this period.. The CHAMP and GRACE satellites are in near-polar and quasi-circular orbits, and together measure the atmospheric drag accelerations, which enable us to derive the thermospheric density response at four local times for each event. These capabilities offer unique opportunities to study the temporal and latitudinal responses of the thermosphere to geomagnetic disturbances. In the present study, the observed response of the thermosphere to the geomagnetic storm of 29-30 May 2003 is analyzed in detail. This event is unique, not because of its magnitude, but because the orbit planes of CHAMP and GRACE were very nearly coincident (less than 0.2 hr local time difference). Therefore, differences in the observed density variations are due to altitude and small time differences (the spacecraft do not pass the same geographic location simultaneously). The variability is evaluated by de-trending the data and analyzing density residuals corresponding to several ranges of horizontal scale. The scale of the perturbation is decisive for its lifetime and relative amplitude. Sometimes the disturbances represent wave-like structures, and for this specific storm several Traveling Atmospheric Disturbances (TADs) were detected, some of which traveled over the pole of the opposite hemisphere. The estimated speeds of the observed TADs are of the order of 500 m/s. TADs are relatively rare in the CHAMP and GRACE density multi-year time series, and their detection is laborious. Besides the May 2003 storm period, we found only twelve additional storm events that gave rise to significant and unambiguous TAD activity.

Keywords: tad, accelerometer

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ASII013 **Oral Presentation** **3220**

Relative importance of the main drivers of positive ionospheric storms

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RELATIVE IMPORTANCE OF THE MAIN DRIVERS OF POSITIVE IONOSPHERIC STORMS N. BALAN(1), H. Alleyne(1), A. D. Aylward(2), Y. Otsuka(3), and B. G. Fejer(4) (1)Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK. (2)Applied Physics Laboratory, UCL, London, UK. (3)STE-Lab, Nagoya University, Japan. (4)Utah State University, USA. Using observations and modeling, the paper presents the relative importance of the main drivers of positive ionospheric storms. In response to two long-lasting CME clouds that flowed pass the Earth during 07-12 November 2004, a rare super double geomagnetic storm with three positive initial phases occurred, and the low-mid latitude ionosphere in Australian-Japan longitude (120-150E) showed positive ionospheric storms in NmF2 and TEC. The Jicamarca IS radar over the geomagnetic equator observed strong east-west electric fields during the storm, with the strongest ever recorded penetrating electric field on 09 November. Using the SUPIM and CTIP models, it is shown that the direct effect of the storm-time equatorward neutral wind (that reduces daytime poleward plasma flow and raises the ionosphere to high altitudes of reduced chemical loss) is the main individual driver of positive ionospheric storms, especially at mid latitudes. The downwelling effect of the wind (that makes the thermosphere richer in atomic concentration and poorer in molecular concentration) contributes to the positive ionospheric storms at low latitudes. The upwelling effect of the wind (that makes the thermosphere richer in molecular concentration and poorer in atomic concentration) and storm-time ionospheric electric field (both penetrating and disturbed dynamo), which cause negative ionospheric storms, also act along with the drivers of positive ionospheric storms. The combined effect of the different drivers can lead to positive ionospheric storms if the main phase (MP) onset of a geomagnetic storm occurs in morning-noon local times. -- 1. Session Code: ASII013 2. Title : Response of the ionosphere-thermosphere to large geomagnetic storms: data availability and modeling. 3. Key words: Positive ionospheric storms, drives 4. N. Balan, Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK Tel: 114-222-5234; Fax: 114-222-5661 E-mail: b.nanan@sheffield.ac.uk 5. Oral 6. PC 7. No 8. No

Keywords: positive, ionospheric, storm

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ASII013 **Oral Presentation** **3221**

Optical Signatures of Large Geomagnetic Storms seen from Ground-based Observatories

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Brian Sharpee

Sky spectra from the VLT (Very Large Telescope) in Chile have been studied for periods when particles from large solar storms were impacting the terrestrial atmosphere – 6-7 April, 2000, 6-7 Nov., 2001, and 28 Oct.-1 Nov. 2003. There are three important nighttime emissions whose behavior is correlated with the Dst index, a measure of the ring current and the equatorial magnetic field. The O+(2Do-4So) emission at 3726-3729 Å, almost never seen at other times, is prominent for a strongly negative Dst (values less than -150 nT), becoming comparable in intensity to the better known O+(2Po-2Do) 7320 Å emissions. The helium 3889 Å emission, normally visible only at dusk and dawn, persists throughout the night under such conditions. Finally, all the OI Rydberg lines, exemplified by the 7774 and 8446 Å transitions, are considerably weakened during storm periods. These effects can be explained by three commonly accepted storm-time phenomena: ionospheric upwelling, thermospheric interaction with ring current electrons, and ionospheric depletion. The first mechanism decreases the collisional quenching of the very metastable O+(2Do) to the point that it can be observed. In principle, the O+(2Po/2Do) emission intensity ratio can be used to extract an approximate density at the emission altitude. The second mechanism allows fast ring current electrons to excite the 19.82 eV He metastable population throughout the night. The third mechanism, ionospheric depletion through storm-time transport of molecular neutrals from higher latitudes, results in lower ionospheric column density. Radiative recombination, the source of the OI Rydberg lines, is thus slowed down at lower [O+] and [e] densities, in a phenomenon akin to the observation of ionospheric bubbles for these transitions.

Keywords: ionosphere, geomagnetic storm, o2d

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ASII013 **Oral Presentation** **3222**

Study of geomagnetic storm effects using digisonde network data

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Vadym Paznukhov, David Altadill, Bodo W. Reinisch

The response of the Earths ionosphere to strong geomagnetic disturbances is still one of the primary subjects in ionospheric science. We present an analysis of the mid-latitude ionospheric response to geomagnetic storms using digisonde observations in the European and American sectors. Existing digisonde network and its database archives offer a benefit of routine round-the-clock ionospheric data collection over a wide range of latitudes and longitudes. Unlike height-integrated GPS measurements, ionosonde observations also make it possible to investigate the effects at different height regions of the ionosphere. For ten major storms of 2001-2005 we analyzed the evolution of the ionosphere making use of the electron density profiles and main characteristics such as foF2, foF1, hmF2, and hmF1. Digisonde measurements demonstrate a strong uplifting of the ionosphere near the electron density maximum observed at all stations for most of the studied storms. For the August 24, 2005 storm event the uplifting occurs in American sector earlier than in European sector and on average about 1-1.5 hour after the sudden storm commencement. For the January 21, 2005 storm the uplifting occurs in both sectors approximately at the same time. We also observe a longer delay in the start of the uplifting for the stations that are located at lower latitudes suggesting that the storm-associated disturbance propagates equatorward. We are trying to establish a correlation between the observed pattern of the ionospheric response and the solar wind shock events recorded during the storms. The mid-latitude coupling to the low-latitude ionosphere is addressed using the measurements at equatorial stations. We present data showing that at the low latitude very strong geomagnetic disturbance can lead to the strengthening of the equatorial fountain effect. It is demonstrated that storms accompanying by IMF changes may result into additional stratification in the equatorial F region, namely to the appearance of an F3 layer. This effect is presumably associated with prompt penetration of the interplanetary electric field.

Keywords: geomagnetic storm, uplifting, digisonde

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ASII013 **Poster presentation** **3223**

Large geomagnetic storms and their manifestation in the ionosphere

Prof. Gely Zherebtsov
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Olga Pirog, Nelya Polekh, Anatolii Tashchilin, Elena Romanova, Jiankui Shi, Xiao Wang

The ionospheric response to a geomagnetic disturbance is a complex set of events caused by both the upper atmosphere and ionosphere parameters and characteristics of the magnetosphere and solar wind. Situation is particularly complicated during the large geomagnetic storm. We present the results derived from investigating of the ionospheric response to large geomagnetic storms with the values of index Dst < -250 -300nT observed during the period 2000-2004. Our analysis of the behavior of the ionosphere is based on using the measurements from a network of ionospheric stations located at different latitudes in the longitudinal sector of 90-150E and the data from the Irkutsk incoherent scatter radar. A comparison between the variations of ionospheric parameters in the east and western hemispheres is performed for some storms. Also there are presented the results of numerical modeling during the geomagnetic storm on April, 2000. Calculations are carried out with correction of the corresponding empirical models according to the available data of different ground observations. This storm is selected for modeling because against its large intensity ((Dst < -300 nT) neither the total absorption nor the blanketing Es layer initiated to the disappearance of reflections from the F2-layer even at high latitudes. It is rare in occurence for storms as large as this. A theoretical analysis of the processes controlling the mid-latitude ionospheric response to the geomagnetic storm shows a good agreement of modeling results and measurements. Besides it makes possible to ascertain the crucial role of the neutral composition variations in the observed variations of ionospheric parameters. At high latitudes the variations of electron density are caused by the combined effect of convection and energetic electron precipitation. It involves an important discrepancy between the observed and calculated values of Ne.

Keywords: disturbances, magnetosphere, convection

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ASII015 **3224 - 3245**

Symposium
Conjugate and interhemispheric polar studies (Division II and III)

Convener : Prof. C. Robert Clauer
Co-Convener : Dr. Kirsti Kauristie, Dr. Mervyn Freeman

The Earths magnetosphere is an electrodynamic system that couples the northern and southern polar ionospheres, each with different geophysical and electrodynamic properties. The unique physical characteristics of the northern and southern polar regions must be considered in models of the fully coupled, global, dynamic geospace system. For example, the separation of geomagnetic and rotation poles, magnetic field strength, and conductivity structures are different in the two polar regions. Further, the solar wind electrodynamic coupling to the northern and southern hemispheres can be very different depending upon the orientation of the interplanetary magnetic field (IMF). Research that quantifies these differences and their consequences is a focus of the International Polar Year and the associated ICESTAR program. In addition, considerable new data should be available from various sources such as ground/satellite conjunctions (e.g. Double Star, Cluster) and the coordinated Themis experiment. These programs along with other national and international efforts are producing new instrument arrays and methods for combining and synthesizing global data sets to investigate the fully coupled solar wind magnetosphere ionosphere system including interhemispheric coupling. This symposium solicits the results from research that contrasts and/or considers the coupled, interhemispheric global system including the consideration of times when the two polar ionospheres may not be coupled. The symposium also solicits papers that discuss the tools that can be used to investigate very high latitude phenomena where traditional CGM coordinates are ineffective. Also appropriate are papers that consider the factors that determine conjugacy/asymmetry of polar cap phenomena Results from observation, theory, and computer simulations are solicited for presentation and discussion in this symposium.

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ASII015 **Oral Presentation** **3224**

Significant North-South and EastWest Asymmetries in the Lower Ionosphere Effects of the Intense Geomagnetic Storms and Superstorms

Dr. Alexander Shirochkov
Division II, III Sessions ASII015, ASIII021 IAGA

Sergey Sokolov

Recent series of the intense geomagnetic storms and superstorms revealed rather unexpected temporal/spatial distributions of the zones of precipitation of energetic charged particles such as protons and electrons. The most reliable proxy of geoeffectiveness of precipitation of these particles is the intensity and duration of ionospheric disturbances produced during these events. The effects in the lower ionosphere are of a special interest since this part of the ionosphere is inadequately covered by the satellite instruments. In this paper ionospheric effects produced by precipitating protons and electrons are analyzed by means of data of ground-based instruments (riometers and VLF phase measurements) as well as by satellite (Sampex and Coronas-F) observations. If the temporal/spatial features of distribution of solar proton fluxes are more or less known the same features of electrons of relativistic and subrelativistic energies are poorly investigated so far. We will analyze several storms and superstorms with a special emphasis on very unusual event of November, 1997. During this event the zone of relativistic electron precipitation protruded deeply inside the polar caps and the both North-South and East-West asymmetries were demonstrated extremely clear. The correspondent ground-based and satellite observations during this and other events will be analyzed carefully. A suggestion is made that observed asymmetry of energetic electron precipitation could be able to explain some the Earths climatic anomalies.

Keywords: energeticprotonsandelectrons, north southasymmetry, east westasymmetry

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ASII015 **Oral Presentation** **3225**

Solar cosmic ray structure and n-s anysotropy in the polar cap and auroral zone

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Solar cosmic ray penetration to the magnetosphere was studied using Coronas-F low altitude satellite measurements of 1-90 MeV protons and 0.3-6 MeV electrons during several SCR events in 2001-2003. At the initial part of the solar cosmic ray event solar particle flux is often anisotropic and particles penetrates freely only in one of the polar cap which magnetic field lines are reconnected with sunward field lines of the IMF. Penetration to the other polar cap became possible due to the diffusion and the penetration rate depends on the particle type and energy. Several features of the SCR spatial distribution inside the polar cap and auroral region are described and suggestions on the magnetosphere structure during quiet and disturbed times are discussed.

Keywords: polar cap, solar cosmic rays, anysotropy

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ASII015 **Oral Presentation** **3226**

Interhemispheric comparison of substorm onset characteristics: Solar wind and ionospheric control

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A detailed statistical study is performed based on 2760 well-defined substorm onsets in the northern hemisphere and 1431 in the southern hemisphere, observed by the FUV Imager on board the IMAGE spacecraft. Southward pointing interplanetary magnetic field (IMF) is favorable for substorm to occur, but still 20% of the events are preceded by northward IMF. One focus is the dependence of the substorm occurrence frequency on season and longitude. It is found that around Dec. solstice the UT noon-time and around June solstice the UT night-time is more favorable for substorms to occur. The occurrence frequency varies up to a factor of 2 over a UT day. The sum of ionospheric Pedersen conductances of the two hemispheres in the pre-midnight auroral regions can account for the seasonal/longitude dependence. Enhanced conductance due to solar irradiation seem to cause a higher substorm trigger level. The magnetic latitude (MLat) of substorm onset location depends mainly on the merging electric field (Em) with a relationship of |dMLat| = -5.2(Em)^0.5. In addition, seasonal effects on onset MLat are also detected. On average they occur at 2 degrees higher latitudes during solstices than equinoxes. Both, the IMF By and the solar illumination have a significant influence on the hemispheric difference in magnetic local time (MLT) of the onset locations. An average relation, dMLT[h] = 0.25By[nT] between IMF By and onset MLT, was found. The By dependence varies slightly with the onset latitude, i.e. an enlarged polar cap reduces the By effect. After removal of the IMF By influence a linear relationships remains between the solar zenith angle (SZA) and onset MLT with dMLT = 1min/degSZA. From all these observations we may conclude that both solar wind and ionospheric conditions control the substorm occurrence frequency and onset locations.

Keywords: substorm, ionosphere, magnetosphere

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ASII015 **Oral Presentation** **3227**

North-South asymmetry of high latitude ULF pulsations during the Magnetic Storm on April 1617, 1999

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Based on the observations in six pairs of almost conjugate high-latitude stations in the Arctic and Antarctic regions, the spectral and spatialtemporal structures of ULF (f = 2 5 mHz) pulsations during the magnetic storm of April 1617, 1999, which is characterized by a high (up to 20 nPa) solar wind dynamic pressure, have been studied. Under the conditions when IMF Bz > 0 and By < 0, strong magnetic field variations with the periods longer than 1520 min were observed only in the northern polar cap. When IMF Bz and By became close to zero, geomagnetic pulsation bursts in both hemispheres were registered simultaneously but differed in the spectral composition and spatial distribution. In the Northern hemisphere, pulsations were as a rule observed in a more extensive latitude region than in the Southern hemisphere. In the Northern hemisphere, the ULF amplitude maximum was observed at higher latitudes than in the Southern hemisphere. The pulsation amplitude at geomagnetic latitude lower than 74 was larger in the Arctic regions than in the Antarctic ones. This can be explained by the fact that the magnetic conjugated Arctic and Antarctic high-latitude regions are located at different geographic latitudes and longitudes. That leads to the significant difference in the local time and in the Sun zenith angle at these areas, e.g. leads to different state of conjugate ionosphere. The inter-hemisphere local time difference increases with the latitude increasing.

Keywords: pulsations, asymmetry

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ASII015 **Oral Presentation** **3228**

High-Latitude Plasma Convection From Cluster EDI Measurements: Variances and Solar Wind Correlation

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Based on drift velocity measurements of the EDI instruments on Cluster during the years 2001 - 2006, we have constructed a database of high-latitude ionospheric convection velocities and associated solar wind and magnetospheric activity parameters. In an earlier paper (Haaland et al., 2007), we have described the method, consisting of an improved technique for calculating the propagation delay between the chosen solar wind monitor (ACE) and Earth's magnetosphere, filtering the data for periods of sufficiently stable IMF orientations, and mapping the EDI measurements from their high-altitude positions to ionospheric altitudes. The present contribution extends this study, by looking at the spatial pattern of the variances of the convection velocities as a function of IMF orientation, and by performing sortings of the data according to the IMF magnitude in the GSM y-z plane, the estimated reconnection electric field, the solar wind dynamic pressure, the season and indices characterizing the ring current (Dst) and tail activity (ASYM_H). The variability of the high-latitude convection shows characteristic spatial patterns, which are mirror symmetric between the Northern and Southern Hemispheres with respect to the IMF B_y component. The latitude range of the highest variability zone varies with IMF B_z similar to the auroral ring extent. The magnitude of convection standard deviations is of the same order as or even larger than the convection magnitude itself. Positive correlations of polar cap activity are found with the IMF magnitude and the reconnection electric field, Ersw, in particular. The strict linear increase for small magnitudes of Ersw starts to deviate toward a flattened increase above about 2 mV/m. There is also a weak positive correlation with the solar wind dynamic pressure, Pdyn. At very small values of Pdyn, a secondary maximum appears, which is even more pronounced for the correlation with solar wind proton density. Evidence for enhanced nightside convection during high nightside activity is presented.

Keywords: cluster edi, magnetospheric convection, solar wind correlation

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ASII015 **Oral Presentation** **3229**

South-north asymmetry of field aligned current in the ionosphere-magnetosphere system

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Using multi-satellite Cluster magnetic field data, we statistically investigated the feature of the Field Aligned Currents (FACs) distribution in plasma sheet boundary layer in the magnetotail. The current is calculated by the curlometer technique with the 4-point measurement data in 2001 from FluxGate Magnetometer (FGM). There are 172 FAC samples chosen for statistics. The results show that the occurrence, density and polarity of the FACs not only have dawn-dusk asymmetry, but also have south-north hemisphere asymmetry. When mapping the FACs along the field lines to the polar region, we found that the print-foot also have south-north asymmetry.

Keywords: field aligned currents, ionosphere magnetosphere, south north asymmetry

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ASII015 **Oral Presentation** **3230**

Comparison of convection patterns inferred from the SuperDARN observations and from FAC-based convection model

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Convection electric fields are mapped regularly by the SuperDARN (SD) network in a significant portion of the high latitude ionosphere in both hemispheres. We have selected periods of good data coverage when the imaging of large-scale convection is fairly precise. We compare the SD convection patterns with the predictions of a new numerical model of the global distribution of ionospheric electric potentials. The model utilizes high-precision statistical maps of field-aligned currents (FAC) derived from measurements made by the Ørsted and Champ satellites. Both the solar and auroral precipitation contribution is included to derive the conductivities. Taking into account the electrodynamic coupling of the opposite hemispheres, the model allows one to obtain the convection patterns developed simultaneously in both hemispheres for given input parameters (the IMF Bz, By, day of the year, UT, Kp, F10.7). The SD instruments provide an unique opportunity to compare the model predictions of electric fields with measurements that were not part of the model input data. Firstly, we calculate the convection patterns for specific cases of strong interhemispheric asymmetry caused by the sign of By, season, universal time (UT) in order to address the following questions: (a) To what degree does the FAC-based model reproduce the radar observation? (b) Are the observed peculiarities of plasma flow controlled by FAC, conductivity or both? (c) What can be the reason of observed variability of the polar cap potential? Secondly, the simulation in the frame of the FAC-based model shows that the solar zenith angle (both seasonal and UT variation) should be linked to the IMF clock angle to fully characterize the convection patterns. That confirms the necessity to link season with the sign of IMF By to fully characterize the dependence of the convection patterns on the season. Finally, we show that, when the seasonal interhemispheric asymmetry in conductivity and in FAC intensity is amplified with the Byrelated redistribution of FACs, the plasma flow at middle latitude is also modified. Specifically, the flow is strongly affected by the corresponding summer polar cap convection pattern.

Keywords: ionospheric, electric, field

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ASII015 **Oral Presentation** **3231**

Cusp-latitude conjugate imaging riometer observations during northward

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Auroral arc with strong green line emissions (> 10 kR) was observed near the magnetic noon on December 4, 1999 at Ny lesund (NAL), Svalbard (76.1˚ MLAT) during a strong bipolar rotation of the interplanetary magnetic field (IMF) from south to north (Sandholt et al., 2002). Simultaneously with this cusp aurora, cosmic radio-noise absorption (CNA) in the polar ionosphere was observed by the 30-MHz imaging riometer (IRIS) with a two-dimensional 8x8 half-wavelength dipole array. The obtained aurora and CNA images showed an identical double-arc structure near the zenith of the station. This result indicates that cusp CNA is useful for studies of reconnection at the dayside magnetopause. It should be also noted that conjugate IRIS observations between the high-latitude northern and southern hemispheres are capable in all seasons. The cusp CNA on December 4, 1999 was simultaneously observed by the 38 MHz IRIS installed at Chinese Zhongshan (ZHS) station (74.5˚ MLAT) in the Antarctica. The CNA feature at the conjugate stations was a spike-type (~ 1 dB) with several-minute duration during the IMF south-to-north rotation, indicating simultaneous magnetic reconnection at cusp poleward boundaries at the high-latitude magnetopause. However, we notice that the CNA images at ZHS showed a single-arc structure arrayed with small-scale spots, being different with the double-arc one at NAL. High solar wind dynamic pressure (~ 10 nPa) during the IMF rotation might differently operate to the magnetic reconnection between the both high-latitude magnetopause, relating to the tilt angle of the Earth magnetic dipole.We present another conjugate CNA event in the daytime of July 10, 2000 during a northward rotation of the IMF. At ZHS, short-lived CNA appeared near the zenith showing an arc-structure, responding immediately to the northward IMF rotation, and also showing a shift toward lower-latitude beams of the IRIS with time. On the other hand, at NAL, arc structure of CNA appeared near the zenith, responding with delay of about 20 minutes after the northward IMF rotation. This conjugate relationship may indicate time-sequential high-latitude magnetic reconnection between the both cusp regions. It should be noted that the CNA at NAL in the summer hemisphere lasted during about 5 hours, synchronized with strong northward IMF swings (~ 10 nT) following the IMF rotation, which might be due to favorable IMF elevation angle (Bx/Bz).

Keywords: cusp latitude, conjugate cna, magnetic reconnection

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ASII015 **Oral Presentation** **3232**

UAMPY: Upper Atmosphere Monitoring for Polar Year 2007-2008

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The UAMPY overall aim is to create new international cooperation in ionospheric research to develop polar upper-atmosphere observation networks for mapping ionospheric features continuously from mid through to polar latitudes, making conjugate studies of magnetospheric-ionospheric coupling processes and relating the large-scale to the small-scale features, in particular the auroral and polar ionospheric irregularities causing scintillation. UAMPY is part of the IPY cluster 63: ICESTAR/IHY and is proposed by INGV (Istituto Nazionale di Geofisica e Vulcanologia Rome, ITALY), IFAC/ISC-CNR (Istituto di Fisica Applicata Nello Carrara/Istituto dei Sistemi Complessi, Florence, ITALY), UNIVERSITY OF BATH (UK), SRC-PAS (Space Research Center, Polish Academy of Sciences Warsaw, POLAND), UNIVERSITY OF CALGARY (CANADA), HMO (Hermanus Magnetic Observatory, Hermanus, SOUTH AFRICA) together with other participants from South African including ISSA (Institute for Satellite and Software Applications), HartRAO (Hartebeesthoek Radio Astronomy Observatory), NWU(Northwest University), UKZN (University of KwaZulu-Natal in Durban), UP (Department of Electrical, Electronic and Computer Engineering, University of Pretoria), CDSM(Chief Directorate Surveys and Mapping, South Africa), and UCT(Department of Electrical Engineering, University of Cape Town). These groups manage several experimental observations in the Arctic and in Antarctica and could allow observation of the polar ionosphere, with extended auroral and polar coverage. As a first step to show the UAMPY potentialities, the group is developing a unprecedented simulation of the TEC (Total Electron Content) scenario overAntarctica considering the existing GPS stations installed and managed by the POLENET community.

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ASII015 **Oral Presentation** **3233**

Different magnetospheric responses to the solar wind pressure pulses

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Magnetospheric response to the solar wind dynamic-pressure jump is a sudden increase in the low latitude on-ground geomagnetic field. This reaction depends on conditions in the IMF. Here we consider "the typical response" of the low-latitude northward magnetic field at the Earth's surface which occurred when Bz IMF turned southward from a near zero level (August 4, 1999). As a result, the simultaneous global increase in the low-latitude geomagnetic field was observed. It was shown by us previously that for several atypical cases the largest positive disturbances were observed on the night side and little or no field increase was registered near local noon. We have shown that for these cases the sudden solar wind pressure pulses were associated with a simultaneous northward turning of the IMF from a near zero Bz.

Keywords: magnetosphere, pressure pulse, solarwind

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ASII015 **Oral Presentation** **3234**

Ground-based HIRISE observations of daytime aurora and sunlit cross polar cap arcs

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Remote sensing of auroral emissions provides us with a unique opportunity to understand the complex interactions between the solar wind and the magnetosphere-ionosphere-thermosphere system. Ground-based auroral observations have traditionally been limited to night time (when solar zenith angle is greater than around 112o) which constitutes of only around 37% of the time. The high resolution imaging spectrograph, HIRISE, is capable of obtaining daytime auroral emissions from the ground. In this paper we present the results obtained by HIRISE from the Sondrestrom incoherent scatter radar facility, at Kangerlussuaq (67o N, 51o W; 74.5o N magnetic latitude) Greenland during 2001. The data includes days with magnetically quiet (Bz around +5nT), disturbed (Bz < -10 nT) and fluctuating (8 to +8 nT) IMF conditions. The OI 630.0nm (red line) daytime emissions show optical signatures of daytime aurora, E-region arcs, cusp emissions, validated by the incoherent scatter radar data. On days with fluctuating IMF (January 22 and 23), the red line emissions range from a baseline magnitude of around 1000 R to a factor of two or more enhancement along the magnetic meridian. We interpret such simultaneous brightening of emissions along the spatial region to be due to cross polar cap arcs or the so-called theta aurora. The WIC/IMAGE images also show cross polar arcs during those days. We will show that our daytime optical measurements from high-latitudes provide high temporal resolution measurements that are essential in understanding the Space Weather effects and the processes related to the intricate Solar Wind-Magnetosphere-Ionosphere-Thermosphere interactions during both quiet and disturbed magnetic conditions.

Keywords: daytime aurora, magnetospheric cusp, mit coupling

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ASII015 **Oral Presentation** **3235**

Modelling two-dimensional cross-phase gradients in high-latitude ULF magnetometer data

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Magnetometer data from Davis, Antarctica (74.49o S, 100.03o E CGM) often exhibit spectral characteristics which can be interpreted as field line resonance (FLR) signatures of the last closed field-lines in the dayside magnetosphere. In particular, cross-phase measurements in the Pc5 band (1-10 mHz) show spatial gradients, which after allowing for mapped propagation from the equatorial magnetopause can provide information on field-line topology via small variations in the resonance frequency. We present here examples of diurnal cross-phase data from two pairs of closely spaced (~110 km), azimuthally separated stations in a square array including Davis. We have constructed a model based on the Tsyganenko (T01) geomagnetic field, and a simple power law plasma density model which allows us to determine the time of flight of Alfvn waves along closed field lines, and thence resonant frequencies. For quiet to moderate conditions we find this model shows good functional agreement with the cross-phase data in two dimensions. Further, we show how polarisation analysis can be used to reveal FLR wave properties that are often masked by propagating waves.

Keywords: magnetometer, ulf waves, resonances

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ASII015 **Oral Presentation** **3236**

Conjugate observations of field-line resonances and the determination of equatorial mass density in the inner magnetosphere

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The Antarctic continent, the only landmass in the southern polar region, offers the unique opportunity for observations that geomagnetically range from polar latitudes to well into the inner magnetosphere, thus enabling conjugate observations in a wide range of geomagnetic latitudes. The SAMBA (South American Meridional B-field Array) chain is a meridional chain of 12 magnetometers, 11 of them at L=1.1 to L=2.5 along the coast of and in the Antarctica peninsula, and one auroral station along the same meridian. SAMBA is ideal for low and mid-latitude studies of geophysical events and ULF waves. We use 5 of the SAMBA stations and a number of conjugate stations from the Northern hemisphere to determine the field line resonance (FLR) frequency of closely spaced flux tubes in the inner magnetosphere. Standard inversion techniques are used to derive the equatorial mass density of these flux tubes from the FLRs. From our conjugate pairs we find, surprisingly, that the derived mass density of closely spaced flux tubes, from L=1.6 to L=2.5, drops at a rate that cannot be predicted by any of the existing models or agree with past observations.

Keywords: field line resonances, plasmasphere, mass density

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ASII015 **Oral Presentation** **3237**

Seasonal asymmetry in the polar cap magnetic activity as a consequence of different electrodynamic coupling in the summer and winter polar caps.

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The unified procedure has been elaborated [Troshichev et al., JGR, 111, A05208] to estimate the magnetic activity (PC index) in the northern and southern polar caps basing on data obtained from Thule (Greenland) and Vostok (Antarctica) stations, correspondingly. While implementing the condition of the PC proportionality to the geoeffective interplanetary electric field (Em), the unified procedure simultaneously ensures general consistency of the unified PCN and PCS indices in their value and behavior. Nevertheless, there are regular discrepancies in PCS and PCN indices determined by difference of the solar wind electrodynamic coupling to ionosphere in the summer and winter polar caps.To demonstrate these discrepancies we examine behavior of the PC index in summer and winter hemispheres in relation to magnetic substorms (AE and AL indices) and pulses of the solar wind dynamic pressure PSW. The statistical analysis of the isolated magnetic substorms occurring on the background of the quiescent magnetic field showed that the sudden substorm onset are preceded by increase of the PC index during the foregoing growth phase. The PC index in summer polar cap (PC summer) turns out to be growing much faster than that in the winter polar cap and reaching, by time of the sudden onset, a higher value than the winter PC index, irrespective of the disturbance intensity. After the sudden onset (during the expansion phase) the summer PC index changes little (or even decreases in cases of powerful substorms), contrary to the winter PC index that changes in conformity with the course of the magnetic bay. The results give evidence that the summer PC index is mostly affected by the merging electric field, contrary to winter PC, which is more related to substorm development. Discrepancy between the summer and winter PC indices is still stronger when the solar wind pressure pulses impinge the magnetosphere. The physical meaning of different behavior of the summer and winter PC indices is discussed.

Keywords: pc index, seasonal, differences

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ASII015 **Oral Presentation** **3238**

SuperDARN observations of Northern and Southern high latitude convection during a positive By period

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We use SuperDARN, ACE, Cluster, Geotail, DMSP and Polar data to study a three hour period (starting at 22:00 UT on 2 January 2003), during which the IMF flipped twice between two states, Bv >>Bz and Bz>0, both with negative Bx. We show that the dayside ionosphericconvection in both hemispheres changes, as expected, with the IMF orientation. Besides, detailed analysis of SuperDARN line-of-sight velocities from the Kodiak and Tiger radars suggests that the convection reconfiguration from a Bz>0 pattern to a B dominated pattern occurs almost simultaneously in the two hemispheres while the reconfiguration from a By dominated to a Bz>0 pattern occurs in the North clearly prior to the South. In this respect, we suggest that Bx<0 is the cause of the time difference observed between the two hemispheres.

Keywords: ionospheric convection, magnetic reconnection, interhemispheric conjugacy

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ASII015 **Oral Presentation** **3239**

The high-latitude ionosphere structure in the two polar regions from the multi-satellite observations

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Structure variations of the high-latitude ionosphere in the two polar regions during March 22, 1979 geomagnetic storm were examined. Data of electron density Ne and temperature Te from the Cosmos-900 satellite (altitude 450 km), NmF2, Ne and He+ from the ISS-b satellite (altitude 1100 1200 km), precipitations of the soft energy near 1 KeV electrons from the Intercosmos -19 satellite (altitude 502 995 km), global picture of the auroral electron precipitations from the DMSP, TIROS and P78 satellites were used. These multi-satellite data let us investigate the positions: of the day-time cusps, of the equatorial boundaries of the main ionospheric trough (MIT), of the day-time and ring ionospheric trough (RIT) and of light ions trough (LIT) during the different geomagnetic storm phases. The high-latitude variations of NmF2, Ne, He+ and Te data for all local time sectors were analyzed. It is shown, that the westward auroral electrojet during the main phase of the geomagnetic storm is located in the morning sector near the equatorial boundary of the auroral diffusion precipitations (DPB). The main ionospheric trough is located about 2 below that DPB, but during the main phase of the geomagnetic storm the MIT was shifted to the equatorward direction and its position became more equatorial than DPB. As result of electron precipitations to its minimum, the MIT was ill-defined this time. Positions of the RIT attributed to the magnetospheric ring current and MIT can be well separated during the geomagnetic storm recovery phase in the two polar regions. The RIT is very deep and narrow in the morning ionospheric sector but during equinox it can be weakly seen on the residual ring current latitudes during daylight hours. Nighttime electron temperature peak at about 6000 is related to the RIT also. Relatively strong daytime ionization trough and the casp peak of Te are formed during the storm recovery phase. It is shown that the light ions trough is restored more slowly in the daytime than in the nighttime. Asymmetric behavior of the ionospheric trough and a peak of electron temperature Te relation to the RIC and to the residual ring current, the plasmapause dynamics and structure position of the high-latitude ionosphere relationships with different geomagnetic indices are discussed.

Keywords: ionosphere, polar regions, ionospheric trough

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ASII015 **Oral Presentation** **3240**

Interhemispheric Asymmetries in the Transpolar Potential: MHD Simulation

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Simulations of the global solar wind-magnetosphere interaction using the Lyon-Fedder-Mobarry (LFM) code has revealed that during strong driving by the solar wind when there is a significant dipole tilt, the transpolar potential develops a significant interhemispheric asymmetry. The dark hemisphere, which has a lower conductivity, has the larger potential, although the sunlit hemisphere generates a larger Region 1 current. Observations from the DMSP spacecraft during the Halloween storms are consistent with such an interhemispheric asymmetry in the potential as demonstrated in the LFM simulation of the event. Because it is possible to run numerical experiments with the LFM code, we have been able to isolate the effects of conductivity and geometry in the generation of the asymmetry. In this presentation I will discuss the nature of the asymmetry, present evidence for its existence, and provide a physical model to explain the origin of the asymmetry in the context of the mechanism responsible for the saturation of the transpolar potential.

Keywords: interhemispheric asymmetries, lfm code, dmsp spacecraft

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ASII015 **Poster presentation** **3241**

ULF noise properties in the Pc5 frequency range at high latitudes in two hemispheres

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Spectral and polarization parameters of the ULF noise in the frequency range 1-4 mHz (Pc5/Pi3) are statistically analyzed in both hemispheres from polar to auroral latitudes. The data from 3 Antarctic station deep in the polar cap (P5,P6 and VOS), 4 Arctic polar stations (ALE, THL, SVS, and RB), two meridional profiles along 40 and 100 magnetic meridians in both hemispheres, and longitudinal profile along the MLAT= +/- 80 are systematically analyzed and compared under various solar wind/IMF conditions. For several nominally conjugated station pairs spectral coherence and correlation functions at different timescales are analyzed to reveal a role of the geographic latitude and inter-hemispheric asymmetry in dependence on the IMF orientation. The actual conjugacy at different latitudes is analyzed by comparison of spectral coherence and correlation coefficients between different station pairs within compact station groups. It is found that, along with similar ULF noise behavior in two hemispheres determined mostly by geomagnetic latitude, MLT, and season, there is a systematic influence of the geographic latitude, especially at high latitudes. A systematic difference between the ULF parameters in two hemispheres is found which can be partly explained by their dependence on the IMF orientation. The position of the points with maximal coherence (actual conjugacy) varies with MLT, frequency, and IMF parameters. The position of actually conjugated points also depends on timescale and differs for elliptically and randomly polarized signals.

Keywords: ulf noise, polar caps, conjugacy

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ASII015 **Poster presentation** **3242**

Long distance monitoring of the lower ionosphere: the global AARDDVARK sensors

Dr. Mark Clilverd
IAMAS

The Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK) provides continuous long-range observations of the lower-ionosphere. It is operating near-continuously in both hemispheres of the globe. The Konsortia sensors detect changes in ionisation levels from ~30-85km altitude, with the goal of increasing the understanding of energy coupling between the Earth's atmosphere, Sun, and Space. We use the upper atmosphere as a gigantic energetic particle detector to observe and understand changing energy flows; this Science area impacts our knowledge of global change, communications, and navigation. The global-scale network of sensors monitors fixed-frequency very low frequency (VLF) communications transmitters; ionospheric modifications up to ~85km altitude lead to changes in the received amplitude and phase. AARDDVARK is a new extension of a well-establish experimental technique, which provides continuous long-range observations of the lower-ionosphere. Subionospheric VLF propagation allows us to undertake remote sensing of the upper atmosphere over large regions; these signals can be received thousands of kilometres from the source. In contrast, incoherent scatter radar techniques and riometers can make measurements in the D-region and above, but are limited to essentially overhead measurements. At this stage AARDDVARK is essentially unique, as similar systems are only deployed at a regional level (e.g., the HAIL array in the central USA). The AARDDVARK sensor network is well suited to provide observations complementary to other ground based and space-based instruments, operating continuously or in high-resolution campaigns.

Keywords: particle precipitation, long range sensing, lower ionosphere

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ASII015 **Poster presentation** **3243**

One mechanism of spatial and temporal variations of concentration of ozone in atmosphere of the Earth

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The dynamics of small relative oscillations of the core-mantle system of the Earth influences the circulation of atmosphere which in turn renders essential influence on ozone redistribution. Ozone participates in redistributions of masses dictated to atmosphere by displaced and gravitating core (Barkin, 2002). One of basic such phenomena is an annual redistribution of atmospheric masses between northern and southern hemispheres. The maximum of atmospheric mass in northern hemisphere decreases to February - March and corresponds to the maximal displacement of the core to the North. Therefore the concentration of ozone in high northern latitudes is increased in the mentioned months and reaches the maximal values about 450 matm. cm. Thus in the southern hemisphere the decrease of concentration of ozone takes place (in March about 200 matm. cm) which starts to increase in September - October and reaches the maximal concentration for the southern hemisphere (about 350 matm. cm). Thus in northern hemisphere the concentration is minimal (250 matm. cm). And further situation repeats with annual cyclicity on which variations with smaller amplitudes and with a wide set of cyclicities from the diurnal to interannual and decadal periods are imposed. On our geodynamic model these variations are inevitable consequence of the small relative oscillations of the core and the mantle of the Earth under gravitational attraction of the Moon, the Sun and planets. The slow secular drift of the core (to the North Pole) leads to secular redistribution of atmospheric mass from the southern hemisphere in northern hemisphere. Hence, an increase of concentration of ozone in northern hemisphere and proportional, but asymmetric, decrease of ozone in the southern hemisphere should be observed. The distribution of linear trends of changes of concentration of ozone shows, that during 1979 - 1999 a similar asymmetry took place actually and in a southern hemisphere a concentration of ozone decreased faster. As a result of long action of the discussed mechanism (at conservation of core linear trend to North Pole) the concentration of ozone in northern hemisphere will surpass considerably the concentration of ozone in the southern hemisphere, as is observed actually (Surkova, Chubarova, 2006). The observed decreasing of the general contents of ozone in atmosphere, and also some of other particularities of spatial and temporal concentration of ozone are determined by others mechanisms. References Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. Surkova G.V., Chubarova N.E. (2006) Nitrogen, oxygen and their compositions. In: Modern global changes of the natural environment. In 2e volumes (Eds. N.S.Kasimov, R.K.Klige) .v. 1. A1. M., "Scientific world". P. 40-55.

Keywords: ozone concentration, hemispheres asymmetry, variations

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ASII015 **Poster presentation** **3244**

Statistical Correlation between GPS Scintillations and HF backscatter

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Ermanno Amata, Giorgiana De Franceschi, Lucilla Alfonsi, Vincenzo Romano, Maria Federica Marcucci, Mark Lester, Peter L. Dyson

It is expected that the level of GPS scintillations observed in the auroral regions correlatewith ionospheric backscatter observed by coherent HF radars. To investigate sucha correlation, we analysed several months of data from the INGV GPS receivers basedat Ny lesund (Svalbard) and M. Zucchelli Station (Antarctica) and from the correspondingSuperDARN radars in the Northern and Southern hemispheres. The correlationbetween GPS scintillations and the SuperDARN HF backscatter occurrenceand spectral width is discussed as a function of season, local time and geomagneticlatitude.

Keywords: ionoshere, scintillation

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ASII015 **Poster presentation** **3245**

Formation of the transition current system in one or two polar caps

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When the solar wind pressure pulse is associated with simultaneous northward IMF rotation from the near horizontal direction, a transition current system arises. This process is connected with corresponding reconfiguration of the field-aligned current system. A transition current system includes the NBZ currents inside the polar cap and the Region I-type currents on the polar cap boundary. This temporary existing current system creates the law-latitude ground magnetic perturbations similar to the effect of the Region I currents. The conditions at the IMF jump determine the arising of the transition current system in one or two high-latitude hemispheres.

Keywords: magnetosphere, ionosphere, currents

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ASII016 **3246 - 3261**

Symposium
Data assimilation and space weather (Division II, III and IV)

Convener : Dr. Ludger Scherliess
Co-Convener : Dr. Tomoko Matsuo

Data assimilation techniques are a dominant tool for specifications and forecasts in meteorology and oceanography. More recently, data assimilation models have also been developed for space weather applications, largely due to the rapid increase in the number of data that will become available over the next decade. This data, which will come from a variety of sources, will be available in real-time for assimilation into physics-based specification and forecast models. In order to adapt modern data assimilation techniques developed in meteorology and oceanography to the near-Earth space regimes, a rigorous examination of the available data, the data assimilation techniques, and the statistical properties of the system is necessary. Papers dealing with data sources, data quality issues, and data assimilation models and techniques are welcome.

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ASII016 **Oral Presentation** **3246**

Imaging and data assimilation in the ionosphere using MIDAS

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Dimitry Pokhotelov, Paul S. J. Spencer, Ping Yin

Tomographic imaging of the ionosphere has developed over the past 20 years into an established tool for ionospheric investigation. The basic technique is based upon the retrieval of the electron-density field from its integrated quantity (total electron content, TEC). MIDAS (Multi-instrument data analysis system) is a flexible mathematical inversion program that has a number of modular options to obtain the spatial field of an integrated quantity. MIDAS contains 3D spatial and time-dependent algorithms. For example, the electron density can be obtained from space- and time-varying data that are related to it in a linear sense. These can be using inputs of TEC (calibrated or relative) from navigation satellites obtained on the ground or in low Earth orbit, from ionosondes, from in-situ probes or from incoherent scatter. A non-linear inversion mode of the MIDAS program also can allow HF oblique sounder or pre-inverted ionosonde data as an input. More recent developments of the MIDAS techniques are now allowing extensions to investigate the underlying physics. For example, in the solar-terrestrial case, tomographic movies showing sudden changes in layer height associated with geomagnetic storms can be investigated using a new image-model coupling program that defines possible model drivers of the system (in this example 4D changes in electric fields). While the image-model coupling approach may not uniquely constrain a full physics model it certainly shows promise as an investigative tool for studying the physics behind extreme ionospheric events that are driven by a single dominant processes coupled from the magnetosphere. Future work will investigate the utility of this approach in studying coupling from multiple sources including the neutral atmosphere. The imaging and data-assimilation (image-model coupling) are discussed in the light of their use in real-time specification and forecasting of ionospheric events.

Keywords: ionosphere, imaging, tomography

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ASII016 **Oral Presentation** **3247**

Prospects for Space Weather Forecasting: lessons from Meteorology.

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Met R&D Met Office, UK IAMAS

Mike Keil

Data Assimilation, in conjunction with physically-based atmospheric modelling, forms the basis of major improvements in weather forecasting that have been realized in recent decades. Space weather prediction lags significantly behind current weather forecasting capability. Many of the issues, questions and techniques related to the analysis and forecasting of an evolving environmental system are common to both space weather and meteorology. Indeed, the thermosphere is one of the key drivers of the ionosphere; modelling the neutral atmosphere could significantly improve the treatment of the ionosphere. In this presentation we compare the physical nature of each problem, how this has influenced the development of numerical weather prediction, and how it could effect the future development of space weather applications. There are some key differences in the nature and provision of observations with practical implications for the implementation of data assimilation systems. We will also consider the application of ensemble forecasting techniques to estimate background error covariances and to provide probabilistic forecasts.

Keywords: assimilation, meteorology

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ASII016 **Oral Presentation** **3248**

Ring current modeling with an algorithm based on the particle filter/smoother

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Genta Ueno, Yusuke Ebihara, Mei-Ching Fok, Shin-Ichi Ohtani, Pontus C:son Brandt, Donald G. Mitchell, Kunihiro Keika, Tomoyuki Higuchi

The inner-magnetospheric processes are strongly controlled by external factors such as the electric field imposed on the magnetosphere and properties of the plasmasheet plasma. Although estimates of these external factors are obtained from empirical relationships with the solar wind condition and then used as inputs in many ring current models, those estimates contain large uncertainties, which may result in large errors in model outputs. In order to achieve quantitative understandings of the ring current dynamics, it is desired to estimate the external factors with high accuracy. For obtaining good estimations of the external factors, we have developed a data assimilation scheme with an algorithm based on the particle filter/smoother. As the effect of external forcings on a ring current state is not immediate but with a delay, the estimation of states at former times is important in data assimilation for ring current modeling. The particle filter/smoother allows us to estimate states at former times with relatively low computational cost. The particle filter often encounters a problem called 'particle degeneration'; that is, a posterior PDF comes to be represented by only a few of the ensemble members after several times of filtering. However, we overcome this problem with a procedure to combine several ensemble members in a filtering process. The present scheme is designed to assimilate the global ENA data from the IMAGE satellite into a kinetic ring current model, the Comprehensive Ring Current Model (CRCM), developed by Fok et al. (2001). We treats some external factors (the electric potential distribution, plasmasheet ion density, and plasmasheet ion temperature) as free parameters, and estimates of those parameters are obtained through data assimilation. In accordance with the estimates of the external factors, the ring current ion distribution is also estimated. We introduce the data assimilation scheme and demonstrate the performance of it through a data assimilation experiment using artificial ENA data generated by another run of the CRCM with a typical setting for the external factors. Some results of data assimilation using real data sets are also shown to illustrate the applicability of the present scheme.

Keywords: magnetic storm, ring current, energetic neutral atoms

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ASII016 **Oral Presentation** **3249**

High-latitude ionospheric scintillation modelling based on satellite in situ data

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Massimo Materassi, Mariusz PożOga, Vincenzo Romano

Signal amplitude and phase fluctuations, known as scintillations, can cause serious problems for the GPS-based navigation, positioning and timing systems. From the users point of view it is important to have a model of scintillation enabling prediction, for a given location and geophysical conditions, of times during which one might expect signal disturbances related to scintillation. The primary cause of scintillation is the signal diffraction on random ionospheric plasma density irregularities (fluctuations). Information about these fluctuations are provided by the in situ satellite measurements. When supplemented with the ionosphere model and irregularity anisotropy model, they can be applied to model morphology of scintillation provided a suitable propagation model is used. This paper will present the scintillation model for the Northern Hemisphere high-latitudes, constructed using the Dynamics Explorer 2 plasma density data, IRI ionosphere model, and the phase screen propagation model. Satellite data were used to derive the spectral index and turbulence strength parameter, while IRI profiles provided information about the peak density, its height, and irregularity slab thickness. The model input parameters are: position of the receiving station, date, local time, magnetic activity index Kp. As the output we get the scintillation intensity index S4. For selected receiving stations, we will compare the modeled and observed S4 index.

Keywords: ionosphere, scintillation, modelling

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ASII016 **Oral Presentation** **3250**

The response of the Earth-ionosphere VLF waveguide to the January 15-22 2005 solar events

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Desanka Sulic, Vida Zigman

The continuous monitoring of VLF signals emitted from NAA/24.0 kHz (44.65N, 67.28W), GQD/22.1 kHz (54.88N, 3.28W) and NWC/19.8 kHz (21.82S, 114.16E) transmitters received by AbsPAL facility at Belgrade (44.85N, 20.38E) revealed different effects of the same huge solar events on three wave traces considered. For the VLF signal on NAA trace the night-to-day amplitude/phase pattern almost diminished for January 17-22, 2005 period. The enhanced level of the daytime signal amplitude to the night time values can be attributed to the severely changed electron density profile, from high to lower ionosphere (enhanced TEC). These conditions held for several days and seem to be initiated by the flare event on January 15, 2005, when SPE and CME were detected in association with X-ray flare of X2.6-class, with the peak at 2302 UT. On January 20, at 0701 UT, X7.1-class X-ray flare occurred, followed by a great solar proton storm affecting the ionosphere in subsequent days. Only the peaks of the greatest X-ray flares can be recognized on the high level amplitude variation. The GQD signal amplitude perturbation is characterized by enhanced daytime levels for the days preceding, and following January 20. After the peak of the X7.1-class flare, the decrease of amplitude level was recorded, indicating the great daytime absorption. By using the Wait's model for the lower ionosphere, it is estimated that the wave reflection height had descended for 7 km, and the electron density had increased for two orders of magnitude, as compared to regular ionosphere conditions (74 km, 2.16·108 m-3). The X-ray irradiance peaks can be recognized as embedded in the high level amplitude variation. On January 21, at 1016 UT an unusually huge amplitude decrease (9 dB) was recorded, associated with a relatively low class flare (M1.8). Amplitude disturbance was also recorded, in the interval 1710-1720 UT, corresponding to electron precipitation (referred by other authors). The NWC signal also showed the departure from regular diurnal pattern. The daytime amplitude level was increased about 4dB throughout the19-22 January period, but X-ray flare effects can be easily distinguished from the background. M-class flares usually cause amplitude increase of few dB on this VLF trace, and we have no explanation (as well as for GQD trace), why January 21, 1016 UT, M1.8-class flare caused an amplitude increase of 8 dB.

Keywords: solar flare, vlf wave

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ASII016 **Oral Presentation** **3251**

Types of VLF amplitude/phase perturbation reveal the properties of the lower ionosphere during solar flares

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Davorka Grubor, Desanka Ulić

En Enhancements of electron concentration in the D-region, induced by solar flares in the wavelength range 0.1-0.8 nm, are studied by very-low frequency (VLF) ground based remote sensing of the lower ionosphere. VLF amplitude and phase data for VLF signals from several transmitters, namely: NAA/24.0 kHz, (44.63N, 67.28W), Maine (); NWC/19.8 kHz, (21.82S, 114.15E), Harold E. Holt (); and GQD/22.1 kHz, (54.88N, 3.28W), Anthorn (UK), have been simultaneously and continuously recorded by the Belgrade AbsPAL logger (44.85N, 20.38E), for the period 2004-2006. In order to avoid differences in seasonal behaviour, records of amplitude and phase flare-induced perturbations pertaining to the summer periods 2004-2006 have been analysed. Four different types of flare effects have been observed: (a) amplitude/phase enhancement, (b) amplitude/phase decrease, (c)amplitude oscillation/phase decrease and (d) amplitude/phase oscillation. Type (a) perturbations appear as distinct VLF response for the NAA and NWC trace, while perturbations of type (b), (c) and (d) seem to be characteristic for the shorter, largely over land GQD path. It is this path that we focus on in the present study, in particular on the type (b) perturbation that appears to be indicative for smaller flares, i.e. of lower class C (up to C4). The reason lies in the aim to inspect the effects of a single flare, on different traces, since for lower X-ray flare irradiances the state of the particular Earth-ionosphere waveguide appears to be decisive. In all the events of type (b) inspected, the single amplitude minimum lags behind the X-ray flux maximum by the time delay (of several minutes), that has been measured and used to predict the enhancement of electron concentration. In this procedure use is made of the flare irradiance data (GOES-12 Solar X-ray Flux data lists), throughout the onset and recovery of the amplitude perturbation. Larger time delays at the GQD path, than the ones recorded for the same flare on traces that exhibit amplitude/phase enhancements (type (a)), indicate deviative absorption as the possible mechanism of amplitude depression near reflection level. The importance of the absolute amplitude change in determining maximum electron concentration is evidenced.

Keywords: vlf amplitude phase, x ray solar flares, vlf absorption

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ASII016 **Oral Presentation** **3252**

Global assimilation of ionospheric measurements: strengths and limitations

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Ludger Scherliess, Jan J. Sojka, Donald C. Thompson, Lie Zhu

As part of the Global Assimilation of Ionospheric Measurements (USU-GAIM) program, we developed two Kalman filter data assimilation models of the global ionosphere, including Gauss-Markov (GM) and Full Physics (FP) models. Our Gauss-Markov model uses a physics-based ionospheric model and a Kalman filter as a basis for assimilating the measurements. The physics-based model is the Ionosphere Forecast Model (IFM), which is a multi-ion global model that covers the E-region, F-region, and topside from 90 to 1400 km. The GM model has both regional and global capabilities and the output of the model is a 3-dimensional Ne distribution at specified times. With the GM model the ionospheric densities obtained from the IFM constitute a background ionospheric density field on which perturbations are superimposed based on the available data sources and their errors. The density perturbations and the associated errors evolve over time via a statistical Gauss-Markov process. Our full physics data assimilation model is more sophisticated than the Gauss-Markov model. This model is based on a physics-based ionosphere-plasmasphere-polar wind model, which includes six ion species (NO+, O2+, N2+, O+, H+, and He+) and covers the low-mid latitudes from 90 to 20,000 km. In addition to the global Ne distribution, the full physics model also provides global distributions of the self-consistent drivers (neutral winds & composition, electric fields, and particle precipitation). Both models can assimilate in situ electron densities from 4 DMSP satellites, bottom-side Ne profiles from 30 ionosondes, slant TECs from up to 1000 ground GPS/TEC receivers, occultation data and line-of-sight UV emissions. The USU-GAIM models are now being widely used, but as with all physics-based data assimilation models, care must be exercised because these models have both strengths and limitations. Some of the important issues relate to the quality, amount and distribution of the data, the ability to obtain reliable errors, representation errors, and the physics contained in the underlying model. These and other issues related to the data assimilation models will be discussed.

Keywords: ionosphere, assimilation, specification

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ASII016 **Oral Presentation** **3253**

Specification of low- and mid-latitude ionospheric dynamics using the Global Assimilation of Ionospheric Measurements (GAIM) model

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D.C. Thompson, R.W. Schunk, J.J. Sojka

It is well known that the ionosphere-plasmasphere-thermosphere system at low and middle latitudes is strongly coupled, and therefore, a study of ionospheric dynamics must take into account the interaction between the different domains. As shown by meteorologists and oceanographers, a powerful way of modeling complex systems is with the use of data assimilation models. At USU, we have developed two GAIM data assimilation models with different complexity and both provide global and regional specifications of the 3-dimensional ionosphere-plasmasphere plasma densities. One of these models is our Full Physics-Based Kalman filter data assimilation model, which is based on a physics-based model for the ionosphere-plasmasphere system, a diverse array of data sources, and an ensemble Kalman filter data assimilation technique. This model covers the ionosphere-plasmasphere system from 90 30,000 km altitude and includes 6 ion species (NO+, N2+, O2+, O+, He+, H+) and needs to be run on a cluster of ~30 CPU workstations. The strength of this model is that in addition to the global and regional 3-D ionosphere electron density distribution it also self-consistently determines the corresponding ionospheric drivers, including the thermospheric neutral winds and composition and the electric fields. The model can assimilate a variety of different data types, including GPS/TEC from up to 1000 ground receivers, in situ Ne from several DMSP satellites, and bottomside Ne profiles from tens of ionosondes. We have used this model to study the dynamics of the low- and mid-latitude ionosphere over the American and European sector, where ground-based ionospheric observations are abundant. The model was used on a case-by-case basis to determine the various driving forces and to study their temporal and spatial variability. We will present examples of the ionospheric and driver variability obtained from our model runs and compare the results with independent data.

Keywords: ionosphere, assimilation, specification

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ASII016 **Oral Presentation** **3254**

On model error growth in applications of an ensemble Kalman filter to the mesosphere and lower thermosphere region

Dr. Tomoko Matsuo
IAGA

Han-Li Liu, Jeffrey L. Anderson, Daniel R. Marsh, Anne K. Smith

In this paper the ability of the Ensemble Kalman Filter (EnKF) to assimilate a realistic set of space-based observations currently available in the Mesosphere Lower-Thermosphere (MLT) region is examined. An EnKF assimilation system has been constructed using a time-dependent, dynamical, chemical stratosphere-mesosphere model with the National Center for Atmospheric Research (NCAR) Data Assimilation Research Testbed (DART). The model error growth in the MLT region and its interaction with the EnKF are crucial in controlling the quality of the assimilations. Sensitivity studies with the the stratosphere-mesosphere model and also with the NCAR Whole Atmosphere Community Climate Model (WACCM) have shown that the dynamics of the MLT are strongly slaved to the tropospheric conditions. In its standard form, therefore, the stratosphere-mesosphere model displayed too little error growth. This leads to insufficient variance in filter assimilation prior estimates, posing the difficulty for the EnKF to assimilate MLT observations effectively. This difficulty can be partly addressed by perturbing the the model's lower boundary. In this talk we will discuss some key issues regarding characteristics of the model error growth in both models (the stratosphere-mesosphere model and the WACCM) and their implication for future EnKF applications to MLT observations.

Keywords: enkf, mlt, error growth

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ASII016 **Oral Presentation** **3255**

State and parameter estimation in radial diffusion model of radiation belts

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As space-borne observations become more plentiful and space-physics models more sophisticated, dynamical processes in the radiation belts can be analyzed using advanced data assimilation methods. We use the Extended Kalman filter, radial diffusion model and observations from the Combined Release and Radiation Effects Satellite (CRRES) to perform estimation of phase space density, the lifetime parameter, and sources of relativistic electrons during magnetic storms in the Earths outer radiation belt.

Keywords: assimilation, kalman

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ASII016 **Oral Presentation** **3256**

The sensitivity of middle atmosphere analyses to data assimilation parameters

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The middle atmosphere is primarily driven by waves generated in the troposphere. Just as waves propagate upward, so too does the information from observations inserted into atmospheric general circulation models. In 3-dimensional (3D) assimilation cycles, this information can be spread during the analysis step through background error covariances or during the forecast step, through the model dynamics. Application of a 3D variational assimilation scheme to the Canadian Middle Atmosphere Model (CMAM) has revealed large sensitivity of the middle atmosphere to assimilation parameters. First, the large variability of the mesosphere implies large forecast error variances which can erroneously spread information upward through nearly zero vertical correlations. This can have grave consequences, such as small data biases in the troposphere rapidly leading to unphysical states in the mesosphere. Second, since both real and spurious information is propagated upward during model forecasts, parameters used to tune gravity wave filtering schemes can impact the diurnal tide, and even the global mean temperature in the mesopause region. This suggests the possibility that mesospheric measurements can be used to tune assimilation parameters.

Keywords: middle atmosphere, mesosphere, data assimilation

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ASII016 **Oral Presentation** **3257**

Validation of a near real time model assisted ionosphere electron density retrieval technique

Mr. Bruno Nava
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Sandro M. Radicella, Pierdavide Cosson

NeQuick is a three dimensional and time dependent ionospheric electron density model developed at the Aeronomy and Radiopropagation Laboratory of the Abdus Salam International Centre for Theoretical Physics (ICTP) - Trieste, Italy and at the Institute for Geophysics, Astrophysics and Meteorology of the University of Graz, Austria. It is a quick-run model particularly tailored for trans-ionospheric applications that allows to calculate the electron concentration at any given location in the ionosphere and thus the Total Electron Content (TEC) along any ground-to-satellite ray-path by means of numerical integration. On the basis of Nequick, a near real time model assisted ionosphere electron density retrieval technique has already been developed. The technique relies on the determination of the model driving parameter Az (ionization level) for suitable locations corresponding to the geographic area of interest. The Az values needed to retrieve the electron density of the ionosphere are obtained by means of the NeQuick model adaptation to GPS derived TEC data. In the present paper a further validation of the proposed technique is carried out and the statistical comparisons between experimental and reconstructed slant TEC values and between experimental and retrieved ionosphere peak parameter values are illustrated.

Keywords: ionosphere, nequick, total electron content

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ASII016 **Oral Presentation** **3258**

FORMOSAT-3/COSMIC ionospheric data processing and availability for data assimilation systems

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FORMOSAT-3/COSMIC, a six satellite constellation, currently provides a wealth of data available for atmospheric and ionospheric research and data assimilation. Each FORMOSAT-3/COSMIC satellite carries three instrument payloads: 1) A Global Positioning System (GPS) receiver, 2) A Tiny Ionospheric Photometer (TIP), and 3) A Coherent Electromagnetic Radio Tomography/Tri-Band Beacon (CERTO/TBB). The focus in this presentation will be on ionospheric data from the GPS and TIP instruments. The GPS receivers measures the L1 and L2 phases and pseudo-ranges from which it is possible to derive the total electron content (TEC) along links to up to thirteen GPS satellites in view at the same time. This includes so-called occultation links which primarily provide information about the vertical electron density distribution below 800 km. By the end of 2007, when the satellites are in their final orbit configuration, they are expected to provide about 3500 near real-time, globally distributed TEC data arcs per day. In addition, the TIP instruments measure the ultra-violet emission due to recombination of oxygen and electrons along the sub-satellite tracks on the Earth's night-side. The processing of the GPS data involves cycle-slip detection and correction, local multi-path mitigation, and calibration for transmitter and receiver differential code biases. Data processing issues, the availability of the data, their spatial and temporal distribution, accuracy, quality, and latency will be addressed.

Keywords: ionosphere, assimilation, gps

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ASII016 **Oral Presentation** **3259**

Regional Multi-Dimensional Modeling of the Vertical Total Electron Content from Sattlite Data and IRI

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IAGA

D. Bilitza (2), W. Bosch (1), C. Zeilhofer (1), C.K. Shum (3), Y. Yi (3), K. Cheng (4)

In this contribution we present a multi-dimensional model of the vertical total electron content (VTEC) consisting of a given reference part, computed from the International Reference Ionosphere (IRI), and an unknown correction term expanded in terms of multi-dimensional B-spline functions. The corresponding series coefficients can be calculated from satellite measurements by applying parameter estimation procedures. Here we use data from dual-frequency altimetry satellites like T/P, JASON and ENVISAT in combination with data from the FORMOSAT-3/COSMIC mission. Altimetry data provide a direct estimate of VTEC values without the need of applying a mapping function. Since data (altimetry and COSMIC) are heterogeneously sampled in space and in time due to the specific orbit and instrument characteristics, a multi-resolution representation like ours will help to generate a homogenous mapping of the VTEC fine structure over data-rich areas. We investigate to what extend the data are able to improve VTEC finer structures in comparison to IRI. The proposed method can be used to study the temporal and spatial characteristics of the Equatorial Anomaly.

Keywords: ionosphere tec, gnss, altimetry

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ASII016 **Poster presentation** **3260**

The influence of solar wind on geomagnetic activity

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Zoltan Voros

Solar wind fluctuations exhibit multi-scale intermittent properties. There exist increasing evidence that these features attributed to turbulence influence the level of the solar wind-magnetosphere coupling. In this work we present a comparison of the intermittent properties of the solar wind fluctuations and the mean values of magnetic field. The main goal is to investigate the correlations between the fluctuations and the mean values of some geo-effective parameters to understand better the relative contribution of intermittence to the efficiency of solar wind-magnetosphere coupling.

Keywords: solarwind, magnetosphere, coupling

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ASII016 **Poster presentation** **3261**

Use of NeQuick model for ionospheric scenarios generation

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Bruno Nava, Sandro Maria Radicella

NeQuick model is a simple electron density profiler of the ionosphere jointly developed at the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy and at the University of Graz, Austria. It is able to compute electron density along arbitrary ground to satelite ray-paths. A simple technique has been developed to adapt the NeQuick driving parameter Az to reproduce experimental total electron content values. In such a way it is possible to obtain a three-dimensional representation of the electron density in the ionosphere both for quiet and disturbed periods. This technique allows to use NeQuick model to generate realistic ionospheric scenarios which can be used to assess ionospheric effects in a region of interest. This paper presents the technique used for scenario generation, and shows various examples of produced scenarios.

Keywords: models, ionosphere, tec

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ASII017 **3262 - 3306**

Symposium
Sun-Earth system: science and impacts (Divisions II, III and IV)

Convener : Dr. Janet Kozyra

Space weather can affect the performance and reliability of space-borne and ground-based technological systems and endanger human life or health. Adverse conditions in the space envirnoment can cause disruption of satellite operations, communications, navigation, electric power distribution grids and impacts the science in all IAGA Divisions. Also, the speed and density of the solar wind and the interplanetary magnetic field (IMF) are thought to affect indirectly the climate system. The pathways that link solar variability to climate and the influences of upward propagating disturbances from the lower atmosphere on space weather involve the sciences in the IAMAS Division. This symposium, which spans IAGA and IAMAS discipline areas, will focus upon descriptions of new impacts and science findings that improve our understanding of the Sun-Earth interaction as an interconnected nonlinear system and will lead to increased reliability in the prediction of space weather and the Earths climate system. Thus, the session will cover the two main thrusts of the international CAWSES program. The science may range from understanding of specific phenomena through to end-to-end modelling of the closely-coupled system. Contributions that address adaption and mitigation strategies and techniques that will minimise the effects of space weather, as well as improvements in the description of coupling mechanisms within the atmosphere that will lead to a clearer understanding of climate variability, are strongly encouraged.

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ASII017 **Oral Presentation** **3262**

CEDAR, GEM and ISTP magnetospheric storms effects on HF radio propagation at high latitudes

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The impact of 14 geomagnetic storms from a list of CEDAR, GEM and ISTP storms, occurred during 1997-99, on radio propagation conditions have been investigated. These conditions were estimated through variations of the MOF and LOF (the maximum and lowest operation frequencies) on three high-latitude HF radio paths in north - west Russia before, during and after a storm. Geophysical data of Dst, Bz, AE as well as some riometer data by Sodankyla observatory, Finland, were attracted for an analysis. It was shown that the storm impact on the ionosphere and radio propagation for each storm has an individual character. Nevertheless, there are common tendencies in variation of the propagation parameters for all storms. Thus, the frequency range = MOF LOF is getting wider several hours before a storm, then it is sharply narrow during a storm-time and further it is expanded again several hours after storm ending. These regularities may be useful for the HF (3.5 27.5) MHz radio propagation tasks at high latitudes. On the transauroral radio path, the full time interval when the path is destroyed throughout a storm (tdes) depends on a local time LT. For the day - time storms an average value tdes is 30%, for the night storm tdes is only 20%. The fact is established that the ionization increase in the F2 layer several hours (4 hours during the day-time and 2 hours during the night) before the storm expansion phase onset may be considered as a reliable forerunner of the storm expansion phase development. By present experimental data, it was revealed that at high latitudes not only the traditional mechanism of the solar energy transfer into the upper atmosphere through the magnetosphere tail, plasma sheet and auroral ionosphere operates but the quite another mechanism also exists through the diurnal cusp and entry sheet of the magnetosphere.

Keywords: storms, impact, propagation

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ASII017 **Oral Presentation** **3263**

Tracking intense geomagnetic storms to the interplanetary mediu: May 15, 2005

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Sergio Dasso

On May 15, 2005, at 02:38 UT an interplanetary shock was recorded by ACE. The following interplanetary structure produced an important geomagnetic storm (minimal value of the Dst index -263 nT). Analysis of interplanetary (plasma and magnetic) observations has shown that these disturbances could correspond to the arrival of AT LEAST ONE magnetic cloud. The main trigger of the geomagnetic storm is definitively the fast halo CME of May 13 (LASCO) observed consequently to the flare occuring at 17:22 UT in the active region 10759. However the analysis of the complexity of the magnetic cloud parameters (ACE) leads us to different possible scenarios for the interpretation, either the existence of two clouds produced by two different events on May 15 (eruption of filaments observed by HASTA), OR the presence of a complex cloud resulting FROM the interaction of the fast CME of May 13 with a previous one occuring on May 11 and triggered by a flare in ANOTHER active region (10758). The helicity and the orientation of the CANDIDATE CMEs and the magnetic clouds are compared in both cases.

Keywords: cme, magnetic cloud

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ASII017 **Oral Presentation** **3264**

Various ways of the solar energy impact on the Earths climate and weather

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Variability of the climate and weather during the last decades demonstrated that the solar radiation (including EUV radiation) can not be unique source of energy for the near- Earth Space. Additional source of energy can be the particles constantly radiated by the Sun surface. Flux of the solar particles includes corona mass ejection (CME), connected with solar flares and local strong magnetic fields as well as a constant emanation of the solar particles connected with weak large-scale solar magnetic fields. Two kinds of the solar particles, which have different long term periodicity of variations, determine energy of solar wind which can penetrate inside the near- Earth Space. Experimental data demonstrated close connection between the atmospheric processes and the solar wind parameters. Processes of transmission energy of the solar wind inside near-Earth Space can be realized by means of the electric fields and currents which changes global electric system of Earth. Our experimental data in the Antarctica (Vostok Station) show a high correlation between values of electric field on ground surface and energy of the solar wind. One of the most important elements of the global electric circuit is a conductivity of the ground surface. So, transmission of energy of the solar wind inside the Earths atmosphere will depend on this important parameter and will be different at different regions of the Earth, producing redistribution of temperature and pressure of the atmosphere. Experimental and model estimations of this mechanism are presented in this paper.

Keywords: solarvariabilty, earthclimateandweather, solarwind

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ASII017 **Oral Presentation** **3265**

Statistic study of large-scale interplanetary phenomena resulting in geomagnetic storms

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We present a comparison of conditions in the interplanetary space during geomagnetic storms which are generated by 2 types of large-scale interplanetary phenomena - corotating interaction region (CIR) and magnetic cloud (MC or interplanetary coronal mass ejection, ICME). We select also 2 geoeffective parts of MC - compressed region ahead of leading edge of MC (Sheath) and the body of MC. Superposed epoch analyses of interplanetary parameters (OMNI database) during 1976-2000 are used separately (1) for 2 epoch zero times: start and end of main phase of geomagnetic storms and (2) for 4 categories of solar wind: CIR (121 storms), Sheath (22), MC (113), and "uncertain"(367). Though the greatest southward IMF component is observed, on the average, in magnetic clouds, the strongest storms are generated by Sheath (but not body of MC). In spite of large differences of parameters in various types of solar wind, the turning of IMF exerts primary control over start and end of a magnetic storm. Preliminary version of results has been published in paper by Yermolaev et al, Cosmic Res. 45, 1 (2007). These facts may be used for modeling interplanetary disturbance formation and dynamics as well as for forecasting the Space Weather conditions near the Earth. Paper is supported in part by Physical Department of Russian Academy of Sciences, Program N 16, Presidium of Russian Academy of Sciences, Program N 16, and by RFBR, grant 07-02-00042.

Keywords: magnetic storm, icme, cir

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ASII017 **Oral Presentation** **3266**

Observations of Pc4 ULF waves at Indian Antarctic station Maitri (L=4.5)

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Magnetospheric ULF waves provide a convenient probe of solar-terrestrial interaction and the topology of magnetosphere. In the present paper, I have studied magnetic pulsations in the 5-15 mHz (Pc4) band observed on October 1, 2003 during 0300-0500UTand 0800-1200UT at Indian Antarctic station Maitri (geom lat. 62degree S, geom. long. 57degree E). One-second data recorded by fluxgate magnetometer with 0.1 nT resolution has been analyzed and most of these events had well defined wave packet appearence in time series records and a clear peak in power spectra. The amplitude, phase, coherence and elipticity etc. were examined for some selected events and results will be presented.

Keywords: ultralowfrequencywaves

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ASII017 **Oral Presentation** **3267**

First-principles modeling of geomagnetically induced electromagnetic fields and currents from upstream solar wind to the surface of Earth

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Our capability to model the near-space physical phenomena has gradually reached a level enabling first-principles modeling of geomagnetically induced electromagnetic fields and currents from upstream solar wind to the surface of the Earth. As geomagnetically induced currents (GIC) pose a real threat to the normal operation of long conductor systems on the ground, such as high-voltage power transmission systems, it is quite obvious that success in accurate predictive modeling of the phenomenon would open entirely new windows for operational space weather products. Here we introduce a process for obtaining geomagnetically induced electromagnetic fields and currents from the output of global magnetospheric MHD codes. We also present metrics that take into account both the complex nature of the signal and possible forecasting applications of the modeling process. The modeling process and the metrics are presented with the help of an actual example space weather event of October 24-29, 2003. Analysis of the event demonstrates that, despite some significant shortcomings, the overall ionospheric current fluctuations associated with GIC can be captured quite well by the modeling process. More specifically, the basic spatiotemporal morphology of the modeled and 'measured" GIC is very similar. Furthermore, the presented user-relevant utility metrics demonstrate that MHD-based modeling can outperform simple GIC persistence models.

Keywords: geomagnetically induced curren, global magnetospheric mhd, forecasting

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ASII017 **Oral Presentation** **3268**

An international integrated research program in South of Brazil for observations of solar-terrestrial interactions

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This overview describes an international scientific cooperation between Brazil, USA and Japan, for an integrated research program developed in south of Brazil for observations of solar-terrestrial interactions and geospace. Space weather variability may damage the satellites in space and also harm systems on the Earths surface like those of electric power transmission lines, telecommunications and GPS based services. Space weather is nowadays in a similar position to meteorology a century ago. We need to understand the physics and develop capacity for space weather forecast in order to reduce the damages to present day technological systems. Observations done by several space missions are important for the understanding of these phenomena, however it is also important to have ground observations, to complement those from space. In this sense, the international scientific cooperation being conducted in Brazil since 2001 is very important, as it will bring development in the strategic areas of national and international interest. A multi-directional telescope for detection of high-energy cosmic rays muons was installed in 2001, through our international cooperation and is operational since then at the Southern Space Observatory SSO/CRS/INPE - MCT, So Martinho da Serra, RS, Brazil, (29S, 53W) whose capacity and sensitivity were upgraded in 2005. The observations conducted by this telescope are used for forecasting the arrival of the geomagnetic storm drivers in the near-earth geospace. Solar mass ejections traveling in the interplanetary space cause reduction in cosmic ray counts at the earths surface by one to ten percent, and can be detected almost ten hours before their arrival at earth if the global network of muon detectors are deployed all over the world by the scheme developed at the Shinshu University, Japan. The Brazilian detector telescope at SSO, So Martinho da Serra, is a part of this muon detector network collaboration, consisting of9 institutes from 7 countries.

Keywords: space weather, cosmic rays, muons

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ASII017 **Oral Presentation** **3269**

Specification and forecast of energetic magnetospheric particles and geomagnetic activity

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Prompt and accurate assessments of enhancements in near-Earth energetic particles are crucial to understanding causes of space system operational problems. For this purpose, it is necessary to know the state of the present (and recent past) space environment. Ideally, this means that one should be able to specify the temporal behavior of energetic particles at all relevant altitudes, latitudes, and local times over the entire energy range of interest to space system operators. Through the use of data from a variety of scientific and operational spacecraft, it has been possible in recent times to develop 'dynamic' radiation models and predictions of geomagnetic conditions. Our present work in this regard uses a variety of data modeling techniques. With such modeling, we are generally able to achieve reasonable accuracies of energetic particle flux specification throughout the outer magnetosphere. We are also able to forecast geomagnetic indices (Ap) and particle fluxes for some 3-4 days based upon analog modeling techniques. Future work employing these methods should allow even more accurate, reliable specification for magnetospheric conditions.

Keywords: energeticparticles, geomagneticindices, spaceweather

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ASII017 **Oral Presentation** **3270**

Solar flare effect on the geomagnetic field and ionosphere

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A solar flare effect (sfe) over the ionosphere and the geomagnetic field during a very quiet geomagnetic period is studied. Then the variations of the geomagnetic field and ionosphere measurements are easily related with the solar flare radiation. On December 13, 2001, an X6.2 solar flare occurred near the solar centre (at solar coordinates N16 E09). This way, it is possible guarantee that the sfe arrive at the Earth. From GOES (Geosynchronous Operational Environmental Satellites) data every minute, the flare started at 14:23 UT and had its maximum at 14:30 UT. Considering that the subsolar point is at 23:18 S and 37.17 W (geographical latitude and longitude respectively), the geomagnetic and ionospheric variations are studied using the measurements of observatories located around the subsolar point at different solar zenith distance. The parameter used to study the ionospheric variability is the vertical electron content obtained from the GPS stations which belong to IGS (International GPS Service). The records of geomagnetic observatories available in WDC Kyoto are used to analyze the geomagnetic variability under SFE.. The time resolution is 0.5 and 1 minute respectively. The geomagnetic data record the solar effect 1 to 3 minutes after GOES reports and in most of the cases the amplitude is lower than 40 nT. Only in few cases the maximum variation reaches values larger than 60 nT and they can be related with the location of these observatories since they are placed near the equatorial electrojet. The VTEC measurements record a sudden variation related to the sfe 0.5 to 2.5 minutes after GOES reports and the maximum variation reaches 6 TECU. The aim of this work is to show the quantitative and qualitative relation between the sfe and the geomagnetic and ionosphere variation.

Keywords: flare, vtec, sfe

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ASII017 **Oral Presentation** **3271**

Solar wind - magnetosphere coupling efficiency: Role of solar wind dynamic pressure

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We investigate the solar wind - magnetosphere coupling efficiency in response to solar wind dynamic pressure impulses. We carry out a superposed epoch analysis of 236 pressure impulses from the years 1998-2002 detected by the ACE/SWEPAM instrument. For the coupling efficiency, we use four definitions based on: the polar cap potential from SuperDARN radars, the northern polar cap index (PCN), the available magnetospheric potential, and the interplanetary electric field (IEF). All definitions show consistent results: the coupling efficiency depends on the internal structure of the impulse. The coupling efficiency increases (decreases) for events mimicking slow (fast) MHD shocks. The coupling energy estimated from the IMAGE magnetometer chain is larger for the "fast-type" events and stronger drivers. Hence, our results indicate that the magnetosphere uses the energy from the weaker driver more geoeffectively, while the energy associated with stronger drivers is partly transmitted through the system.

Keywords: magnetosphere, ionosphere

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ASII017 **Oral Presentation** **3272**

Systematic study of the response of the pipe-to-soil voltages induced in the Czech oil pipelines on geomagnetic disturbances

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Our previous study of the geomagnetically induced pipe-to-soil voltages in the Czech oil pipelines during Halloween geomagnetic storm revealed different in size and shape response on the magnetic disturbances not only in different pipelines but also in nearby parts of the same pipeline (Annal Geophys, 23, 3089-3093, 2005). As the study was based just on data from a few stations we have now carried out a careful investigation of data from 60 stations for monitoring of cathodic protection distributed over the entire network and covering magnetically quiet as well as disturbed periods. The analysis of quiet periods enabled to assess the level of voltages induced by industrial sources. The highest disturbances proved to be caused by stray currents in the neighbourhood of DC supplied railways. The results of the above analysis were then used in the interpretation of pipe-to-soil voltages observed during strong geomagnetic storms.

Keywords: induced voltages, geomagnetic storms, stray currents

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ASII017 **Oral Presentation** **3273**

Effects of solar wind speed in driving magnetospheric activity

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We show statistical results of substorm-like events during magnetic storms, sawtooth events, and steady convection periods to demonstrate that the solar wind speed is a major parameter in determining the type of magnetospheric activity that follows even when the driving solar wind electric field has approximately similar values. Further statistical analysis of all periods shows that for the same solar wind electric field value, larger V and smaller B drive higher activity than smaller V and larger B. Furthermore, we show global MHD simulation results that indicate that the solar wind speed is a parameter in determining the efficiency of the energy transfer from the solar wind into the magnetosphere, and that the solar wind speed indeed is a factor contributing to the global state of the magnetosphere.

Keywords: storm, substorm, sw m coupling

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ASII017 **Oral Presentation** **3274**

MHD modeling of varying solar wind and IMF propagating from L1 to Earth

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In recent years, significant progress has been achieved in understanding solar wind propagation from the Sun to the Earth's orbit and its interaction with the terrestrial magnetosphere by using global massively parallel MHD models with adaptive grids. Most global magnetospheric models, however, require knowledge of the solar wind parameters (speed, density, and IMF) at about 35 Re upstream from the Earth where the inflow boundary conditions are imposed. In reality, the solar wind conditions are typically measured in the vicinity of the L1 point which is located approximately 200 Re upstream. To date, only limited attention has been given to the actual propagation of the varying solar wind from L1 to the Earth's bow shock. If the plasma flow were homogeneous and steady, then this 200-Re distance would be covered by solar wind in about an hour, and the flow parameters measured near the bow shock would be the same as at L1. There are numerous techniques developed for describing the transport of solar wind plasma through this domain ranging from simple ballistic propagation to the methods involving minimum-variance analyses. None of these methods, however, provides a clear understanding what might happen with the solar wind in this domain when slower and faster flows are interspersed, and various SW and IMF discontinuities interact while moving through the slower ambient plasma. To address this, we therefore present some MHD modeling results for the realistic propagation of the solar wind and IMF disturbances from the L1 location to the Earths bowshock and magnetopause.

Keywords: mhd, solar wind, imf

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ASII017 **Oral Presentation** **3275**

Solar corona effects on angle-of-arrival fluctuations for RF telecommunication links during superior solar conjunction

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During the superior solar conjunction of spacecraft, the transmitted signals from spacecraft to the Earth ground station graze the region near the suns photospheric surface, passing through dense and turbulent regions of solar charged particles. These signals suffer phase changes as a result of raypath wandering and wave front tilting effects of the irregularities of the solar corona, which produces fluctuations in the apparent angle of arrival when observed from the Earth. This study presents a complete theoretical investigation of the solar wind and solar coronal effects on the angle of arrival fluctuations for RF signals. Starting from Chandrasekhar relation of the phase and the angular errors, after applying available solar corona models, an analytical integrating solution of angle-of-arrival fluctuations is derived. It is found that angular fluctuations rapidly decrease with increasing heliocentric distance at a rate of ~r-5.5, and also decrease with increasing frequency at a rate of ~1/f2. After calibrating coefficients of the solution using previous measurements made at larger solar grazing distances, the angular fluctuations as a function of Sun-Earth-Probe (SEP) angles are calculated in a region very close to the sun. It is found that at Ka band at α = 0.4 (r = 1.6 solar radii), there is a 19 mdeg angular scattering, corresponding to a 9 dB gain degradation due to pointing errors. In comparison, X and S bands have much worse degradation effects. The Mars Reconnaissance Orbiter (MRO) with a similar superior solar conjunction in the near future will experience such angular fluctuations as we predicted from this study. Beyond α = 2 (r > 8 solar radii), angular fluctuations at microwave frequency bands almost can be neglected (< 1 mdeg). A solution to minimize this effect of degradation is to use Ka or higher frequency bands for telecommunication link during the solar conjunction. This study not only quantifies the angular fluctuations caused by solar corona irregularities, but also provides an effective method in diagnosing the plasma density fluctuations in a region very close to the solar surface.

Keywords: solarcorona, solarconjunction, angle of arrivalfluctuation

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ASII017 **Oral Presentation** **3276**

Solar-Wind Sources for Large-Scale Disturbances (including Super Substorms) during Geomagnetic Storms

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We have previously identified different types of IMF and solar wind changes that lead to disturbances and features of the resulting disturbances. Here we use global auroral images, geosynchronous particle data, and ground magnetometer observations to investigate how this categorization applies to disturbances during storms, with a focus on sawtooth event disturbances and super substorms during the storm main phase of severe storms. Our results indicate that pressure triggered substorm responses are far more common than average during storms, since pressure increases are more likely to trigger substorm disturbances under strongly southward IMF conditions. This offers an explanation for the global nature of many sawtooth disturbances because pressure increases cause global compression in addition to a nightside substorm, and both increase the aurora and energetic particles. Sawtooth events also include a number of subsidiary events. We have found that several subsidiary substorm events occurred close (<45 min) to major teeth and to each other, implying there is not an intrinsic ~2-4 hr periodicity of substorm disturbances during sawtooth events. We also find evidence that the super substorms identified during the storm main phase are the same phenomenon as pressure triggered substorms that occur following prolonged periods of strongly southward IMF and that constitute many teeth of stormtime sawtooth events. Additionally, we find evidence that with extremely large |By| or extremely large negative Bz, the normal requirement for prolonged (> 1 hr) southward IMF may not be necessary for there to be a pressure triggered substorm.

Keywords: strorms, substorms, sawtooth events

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Submitted to Wrong Session---withdrawn

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Submitted to Wrong Session---withdrawn

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ASII017 **Oral Presentation** **3278**

Dependence of DST and AE indices on the magnetic cloud electric field as an indicator of the type of magnetic clouds

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The influence of the interplanetary electric field Ey for different types of magnetic disturbances is studied. The characteristic dependence of Dst and AE on the electric field of magnetic clouds caused by unipolar and bipolar activations on the Sun is discussed. It is assumed that dependences obtained can be used as an indicator of the type of magnetic clouds and also to make more precise the geomagnetic forecast.

Keywords: magnetic clouds, interplanetary electric field, geomagnetic indices

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ASII017 **Oral Presentation** **3279**

On the nature of the solar influence on climate and its contribution to climate change

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Fernando Luis Guarnieri

The influence of solar magnetic variability on the lower atmospheric regions has been observed on several time scales. However, a plausible mechanism to explain these observations remains unclear. It is also indistinguishable whether the variability of the solar-terrestrial coupling drives the present climate change. New observations suggested that the existence of a geomagnetic signal in climate data would support a direct link between solar variability and their effects on climate. Usoskin and colleagues compared 1000-year reconstructions of sunspot numbers and cosmic ray flux (derived from cosmogenic isotope data) with air temperature historic records in the Northern hemisphere. They observed higher temperatures during periods of intense solar activity. In addition, they report that three different statistical tests consistently indicate that the long-term trends in the temperature correlate better with cosmic rays than with sunspot numbers. Vieira and Da Silva observed that the clouds effects on the radiative flux in the atmosphere in the southern Pacific are related to the intensity of the geomagnetic field. They have also observed a cosmic ray modulation of the variability of the long wavelength radiative flux in the atmosphere. More recently, Vieira and colleagues reported that a correlation between increasing sea-level pressure in the tropical Pacific, and decreasing magnetic field intensity is observed. This indicates that physical processes in the magnetosphere, ionosphere and upper atmosphere can be mapped downward to the Earths surface. It was suggested a coupling mechanism linked to the ozone depletion in the lower mesosphere and in the upper stratosphere of the auroral region, and/or the southern hemisphere magnetic anomaly region. The depletion is caused by high energy protons produced during solar proton events (SPEs) released during large solar storms. Variations in solar irradiance, in ozone levels produced by highly energetic protons, and/or electron precipitation in the magnetic anomaly (or auroral region) may lead to small but significant changes in global weather patterns. Numerical experiments have shown that slight changes on stratospheric diffusion result in quite different tropospheric circulations, when compared to unperturbed conditions. If the solar activity modulates the mesospheric and stratospheric, temperature and dynamics in this way, most of the observed correlations between cosmic rays and cloud coverage, at least in the south Pacific, may be due to changes in the circulation patterns. This view is opposed to atmospheric ionization, and changes in the atmospheric electric field due to cosmic rays. Here we discuss the fundamental physical processes of the space environment from the Sun to Earth. Furthermore, we investigate the possible connection between geomagnetic field configuration changes and the increase of the Earths temperature.

Keywords: solar variability, atmospheric circulation, climate change

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ASII017 **Oral Presentation** **3280**

Estimates of NO variability in response to geomagnetic activity and its influence on the middle atmosphere as determined from SABER

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The SABER instrument on the TIMED satellite has recorded 5.5 years of observations of the thermal structure, composition, and energy balance of the Earths stratosphere, mesosphere, and thermosphere. The thermospheric nitric oxide (NO) emission at 5.3 um observed by SABER exhibits large variability from day-to-day, driven apparently by the short-term variability in geomagnetic conditions. This variability in the NO emission reflects primarily the variability in NO density on short timescales, although in extreme events the temperature, NO density, and atomic oxygen concentrations are all perturbed sufficiently to cause changes in the NO emission. SABER also observes the ozone concentration from the tropopause to approximately 100 km altitude. The SABER observations allow us to assess the role of space weather in influencing the energy balance of the thermosphere and the ozone abundance in the stratosphere and mesosphere. In this talk we will examine the time series of NO emissions and ozone abundance and explore couplings between the space environment and the neutral atmosphere.

Keywords: ozone, space weather, nitric oxide

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ASII017 **Oral Presentation** **3281**

Effects of Solar Energetic Particles and Radiation Belt Precipitation on the Middle Atmosphere and the Global Electric Circuit

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Two recent southern hemisphere balloon campaigns have afforded unique opportunities to study the coupling between energetic particle precipitation, stratospheric conductivity and the global electric circuit. This paper will present highlights of two related observations: modulation of the stratospheric conductivity and the global circuit by precipitation of energetic trapped protons and shorting out of the global circuit by a solar energetic particle event The first event occurred on 27 January 2003, when a very pronounced negative ion conductivity enhancement was observed by only one of two nearby balloons from 1500 to 2200 UT. During this event, the conductivity doubled for an interval of about 7 hours. This perturbation was associated with an extensive Pc 1 or Pi 1 wave event that was observed by several Antarctic ground stations, balloon PPB 10, and the Polar spacecraft. No appreciable X-ray precipitation was observed in association with this event, which would point to energetic proton precipitation as a possible magnetosphere-stratosphere coupling mechanism responsible for the conductivity enhancement. Such precipitation is consistent with the wave data. Precipitating > 16 Mev proton precipitation was observed by the Akebono and NOAA POES spacecraft. This event might represent a hitherto unrecognized source of modulation of the global circuit current. The second event occurred January, 2005, when there were several large X-class solar flares and associated solar energetic particle (SEP) events. Coincidentally, the MINIS balloon campaign had multiple payloads aloft in the stratosphere above Antarctica measuring dc electric fields, conductivity and x-ray flux. One-to-one increases in the electrical conductivity and decreases to near zero of both the vertical and horizontal electric field components were observed in conjunction with an increase in particle flux at SEP onset. Combined with an atmospheric electric field mapping model, these data are consistent with a shorting out of the global electric circuit and point toward substantial ionospheric convection modifications. However, rapid jumps in the vertical field several hours after SEP make the MINIS observations unique. Each of these jumps is accompanied by an intense burst of ELF emission. When SEPs penetrate into the collisional atmosphere, they increase electrical conductivity by ionizing neutrals before stopping and depositing their net charge. Sudden modulations to the local SEP flux and spectrum lead to changes in magnitude and altitude of both charge deposition and conductivity enhancements, which could account for the observed electric field jumps. Understanding these sudden vertical electric field jumps at the particular balloon location will give us insight on how the global electrical atmosphere responds to intense SEP event.

Keywords: energetic particles, global circuit, electric fields

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ASII017 **Oral Presentation** **3282**

Intermittent plasma jets and magnetic barriers: about possible impacts on the Sun Earth connections

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Basing on comparison of the Cluster, Interball, Polar and Geotail data we discuss some new phenomena, which should influence on the Sun-Earth interaction chain. One of most powerful structures, regulating flow, mass and energy balance of the solar wind (SW) interaction with magnetospheric obstacle, are concentrated in ram pressure plasma jets. They represent the ram pressure enhancements in several times over that of SW in the shocked magnetosheath (MSH) plasma of several tens of minutes duration, which often skew a magnetopause (MP) with much less magnetic pressure in front and just behind the MP. We demonstrate a class of the jets without direct driving by SW, which often cant be accelerated by a magnetic reconnection, while can drive a secondary reconnection at the MP. We show a Cluster case with the tremendous jet, flowing at ~ 10 degrees to X GSE axis, supersound, highly super-Alfvenic, which cannot be stopped by a magnetic field behind cusps, and thus penetrating through plasma mantle in the distant tail. Cross-correlation between Clusters, Interball, Polar and Geotail spacecraft shows transverse jet scale of several thousand km and parallel scale up to few RE. The jets looks to be universal means for quasi-steady MSH flow balance (~ 30%), removing of the momentum excess in MSH after the SW flow drops, and for removing plasma in front of approaching boundaries. One of a mechanism for the jet acceleration is the Alfvenic collapse- predicted by MHD infinite rise of piled-up magnetic field lines in 3D transverse flow disturbances. The rising magnetic pressure can become dominating even in the regions with dominant ion pressures, providing an effective interface between moving MSH and stagnant cusp plasmas. We discuss implementation of the Alfvenic collapse also for the boundaries at convective cells on the Sun surface. Finally we suggest that such powerful intermittent phenomena as the jets and collapsing barriers should be systematically studied for accounting of the mass, momentum and energy flows in the chain of the Sun-Earth interactions. This work was supported by ISSI and INTAS-03-50-4872 and 05-1000008-8050 grants.

Keywords: sun earth connections, strong plasma jets, alfvenic collapse of barriers

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ASII017 **Oral Presentation** **3283**

Ground effects of November 2004 space weather event

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Space weather events with their solar origin and their distribution through the whole solar system affect the global Magnetosphere-IonosphereEarth system. Here we discuss one of the most difficult periods to forecast and also one of the largest space weather events of the current solar cycle 23. Nine halo coronal mass ejections (CME), interacting on their way through the interplanetary medium and forming two geo-effective interplanetary structures defined the complexity of the November 2004 event. Real-time and quasi real-time observations of the ground geomagnetic field show rapid and extensive expansion of the auroral oval to 55 degrees in geomagnetic latitude accompanied by great variability of the ionosphere. Geomagnetically induced currents (GIC) seen in ground networks, such as power grids and pipelines were significant during the event. Forecasts of the local ground geomagnetic activity issued by the Regional Warning Centre (RWC) revealed major deficiencies in predictions of the characteristics of the geomagnetic disturbances produced by this event.

Keywords: event, observations, forecast

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ASII017 **Oral Presentation** **3284**

Great geomagnetic storms in solar cycle 23

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In this work, we study the great magnetic storms in solar cycle 23. Since 1996, the post-SOHO era, we had a number of 18 Dst<-200nT events, which where observed continuously, both near the sun and in the near-earth interplanetary space. We use data from the Large Angle and Spectrometric Coronagraph and the Extreme Ultraviolet Imaging Telescope, both aboard the Solar and Heliospheric Observatory, to identify the solar origin of these events. Solar wind and interplanetary magnetic field from the Advanced Composition Explorer are used to study these events in terms of their interplanetary structure. In terms of solar sources of these extreme events, all but one were associated with coronal mass ejections alone, while one event was related to a coronal hole high speed stream interacting with a slow CME.

Keywords: great magnetic storms, solar cycle 23, coronal mass ejection

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ASII017 **Oral Presentation** **3285**

Space weather forecast of radiation belt electrons during magnetic storms driven by CMEs and CIRs

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Radiation belts show various patterns of evolution during a few days after a magnetic storm onset, and the prediction has been a difficult problem. Using a 10 year data set of the sun, solar wind, radiation belts, and geomagnetic field, we show that the outer radiation belt tends to be more dangerous for geosynchronous satellites than usual during storms associated with coronal holes and corotating interaction regions, and that the outer radiation belt tends to be rather safe during storms associated with coronal mass ejections. In this paper, we report our new results as a nice example of a challenging effort for predicting the space weather in the Sun-Earth coupled system. It is apparent from our results that the solar wind speed, the fluctuation of the interplanetary magnetic field (IMF), the offset in the north-south component of the IMF Bz, and the pre-storm condition of the magnetosphere seem to play an important role to control the outer belt electrons. We show the meaning of these parameters in terms of the large-scale solar wind structures, and quantitatively evaluate the relative importance of the solar wind speed, IMF, and preconditioning of the magnetosphere.

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ASII017 **Oral Presentation** **3286**

Variations of Terrestrial Plasma Environment during the 23rd Solar Cycle: Geotail/EPIC Observations of Ion Composition

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One of important issues of the terrestrial plasma environment is ion composition. Plasma around the Earth predominantly consists of H+, but it includes other ion species, such as O+ and He2+. Since these ions are heavier than H+, even small amounts of them will modify properties of the plasma. Some previous studies have shown that the He+ and O+ densities (or energy densities) are correlated with the F10.7 index, but the results were derived from data sets covering a period much shorter than one solar cycle (less than 4.5 years). To confirm the solar activity dependence of ion composition, it is desirable to use a long-term data set that covers more than 11 years. The Geotail spacecraft was launched on July 24, 1992 and is still operating as of February 2007. In the early phase of operation the spacecraft surveyed the distant tail of XGSM=50 RE to 210 RE. In March of 1995, the spacecraft was maneuvered into the final near-Earth orbit having a perigee of 8-9 RE, an apogee of 30 RE, an orbital period of ~5.5 days, and an apsidal period of ~1 year. The EPIC (energetic particles and ion composition) instrument onboard Geotail can measure energetic ion flux with mass and charge state information. The energetic ion flux data have been accumulated for more than 14 years, covering the entire 23rd solar cycle. Thus this unique data set makes it possible to investigate variations of ion composition in the plasma sheet over one solar cycle for the first time. We found that the O+/H+ and He+/H+ integral flux ratios are controlled by solar activity, while the He2+/H+ and (O6++O7+)/H+ ratios are at almost constant levels.

Keywords: ion composition, 23rd solar cycle, plasma sheet

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ASII017 **Oral Presentation** **3287**

Relationship between the IMF orientation and the F region trough

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Tuomo Nygren

The horizontal transport of plasma is often considered to have a major contribution to the formation of the F region trough. The horizontal convection is governed by the polar cap convection, which, in turn, is intimately related to the structure of IMF. We investigate here the possible relationship between the IMF orientation and the occurrence of the trough in the auroral region between 55 and 75 degrees. We use the results of a previous statistical study based on satellite tomography observations and the convection model by Papitashvili and Rich (2002). The poleward and equatorward edges of the trough are determined from the satellite data and their locations are plotted in magnetic co ordinates together with the convection pattern. The results indicate a close relationship between the troughs and convection, especially for equinox seasons. More day-side troughs are observed when Bz is negative and, consequently, the convective flow is fast, than in the opposite case. Also, the pattern of trough observations rotates with the convection pattern, when By changes its sign from negative to positive. It is concluded that plasma convection and recombination in the night-time ionosphere has a major role in trough generation, although other mechanisms like precipitation certainly have a role of their own. The relationship is less clear for the remaining seasons. The implications of the present study for the study of the F region trough are discussed.

Keywords: f region trough, interplanetary magnetic field

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ASII017 **Oral Presentation** **3288**

The role of solar-modulated small scale drag in the upper atmosphere in driving the global residual circulation.

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The net transport of heat and chemicals in the Earths atmosphere has been shown to be driven by changes in planetary and gravity wave fluxes by Andrews and McIntyre and others. However, as they were principally concerned with the middle atmosphere, they assumed that acceleration due to small scale friction and ion drag was not important. These assumptions break down in the thermosphere. Using a mechanistic three dimensional model of the coupled middle and upper atmosphere we show that as these neglected terms become significant in the upper atmosphere, they also contribute to the global scale circulation down to the lower atmosphere. We discuss the implications of these results for studies of global climate change.

Keywords: solar, climate, variability

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ASII017 **Oral Presentation** **3289**

Annual and UT distribution of appearance frequency for large geomagnetic disturbances as base for prediction of space weather hazards

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Super geomagnetic storms are usually considered to be unpredicted. But it is very important to study regularities of appearance of large geomagnetic disturbances to increase our predictive capability for space weather. Statistical geomagnetic activity (GA) is well-known to be described by season variation with maxima in vicinity of the equinoxes and minima near the solstices. Cause of this annual variation is still unknown. Clua de Gonzales et al (2001) using monthly averages of geomagnetic indices found peak in July for ranges of high levels of geomagnetic activity that is outside of the known seasonal profile of GA. The purpose of our study was to obtain annual and UT distribution of appearance frequency of high values of geomagnetic activity (expressed by indices of GA) in year using two week averages. For our study we used geomagnetic indices Kp (1932-2004), aa (1868-2004) and Dst (1957-2004). We obtained for all the geomagnetic indices that as the level of intensity increases, the classical season variation has additional peaks. For strong disturbances in range of Kp=8-9 we obtained clear non-classical season variation with additional peak ~15 July comparable with peaks at equinoxes. We see the same positions of peaks and their intensity for level aa>200: additional peak at ~15 July. The summer peak in July differs from the peaks in vicinity of equinoxes: gradual increasing of geomagnetic activity before maximum at the equinoxes and sharp rise of geomagnetic activity in July from low activity to its highest level that lasts for ~2 weeks. Annual variation of Dst< - 200 nT shows clear main peak at~20 November and less intensive peak in July and near equinoxes. So, amplitude of these peaks in distribution of appearance frequency during year is comparable or even higher (as for Dst< -200 nT) with known peaks near equinoxes. Our analysis shows that UT variation of all discussed indices for the high level of geomagnetic activity (Kp>8, aa>200, Dst< - 200 nT) have clear additional peaks at ~6UT and ~18 UT on usual statistical profile of the UT variations of the indices. Our study based on spaced measurements of the solar wind velocity V and the IMF B at the Earth's orbit (1963-2005) showed that module of the solar wind electric field E=[VxB], module of Poynting vector P=[ExB] have clear annual variation. Annual variation of Pmod and of Emod has two main peaks in November (main) and in July (less than main). Besides, annual variation of Pmod and of Emod depends from 22-year solar cycle: all values of Pmod and of Emod are considerably higher in odd 11- year cycles (N21 and N23) than in even ones (N20 and N22). Pronounced peak in November is feature of cycles N21 and N23. Profile of annual variation of Pmod and of Emod for the cycle N22 and N24 (with peaks near March and October) is close to classical variation of GA. The fact that large geomagnetic disturbances are observed during narrow intervals of UT in a year allows us to improve our predictive capability for large geomagnetic disturbances. Our initial results about connection of annual and of UT variation of the parameters of the solar wind (values of E and P) with simular variation of large geomagnetic disturbances allows to hope to identify sources of the space weather hazards in the next future.

Keywords: space, weather, disturbances

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ASII017 **Oral Presentation** **3290**

The time varying sun in the solar wind velocity and in the inteplanetary magnetic field in near - Earth space

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We present results of our analysis of spectra of module of the Interplanetary Magnetic Field (IMF), the solar wind velocity (V) calculated on the basis of data for the period of spaced measurements at the Earth's orbit and of solar activity (sunspot numbers W). We put as our aim to search for oscillations with common periods in the spectra in various frequency bands (with stress on the period T~11 yr of main solar cycle and its harmonics and on so called "intermittent" oscillations at periods T~1.3 yr and T~150 days); to extract trends from the data to determine value of long-periodic changes of IMF, V and W. A method of non-linear spectral analysis named by us the Method of Global Minimum (MGM) is used. MGM allows self-consistent identification of trends from data and non-stationary harmonics (amplitudes and phases depend on time) and estimation of statistical significance of spectral components. Spectra of the IMF value and W have main solar cycle at T=10.8 yr. besides, spectrum of the IMF (at confidence level 99.8%) has overtones of the cycle at T=10.8 yr (T=151.4day, T=136.5 days). We detected non-stationary oscillations at T=1.3 yr in the spectra of IMF and V connected with periodic variations in the rotation velocity near the base of the convective zone of the Sun discovered in the SOHO data. These oscillations do not present in the W spectrum. Instead we found non-stationary oscillations at T~1.0 yr (370 day) in the solar spectrum and suggested explanation for the difference of periods. The relation between the oscillations in the spectra of W and V is not as evident as between W and the IMF, however, it exists. In particular, overtones of the 10.8-year solar cycle present in the spectrum of V (such as power oscillations at T=1.55 yr); main solar cycle at T=10.8 yr is the 5-th overtone of the longest period in the V spectrum at T=(544) yr. Oscillations with common periods of T=10.8, T=8.8, and T = 3.73 yr have been identified in the spectra of W and of IMF. The temporal variations of these cycles demonstrate the different nature of the relation between solar activity and the IMF value: the cycles with T = 10.8 yr vary in phase, variations of the cycles at T = 8.8 yrs are shifted in phase. It is interesting to mark that the most power sinusoid of spectrum of sunspot numbers W for the last solar cycle (1996-2004) at T=16.56 yr can be interpreted by period of perturbed tide force of system Jupiter-Uranus (the spectrum of W has the main period and overtones); this component of tide force is connected with motion of the Sun relative mass center of the Solar system. Effect of this sine wave is important on development of cycle 23. Trends and the long-periodic part in the spectra have the highest amplitudes that points to their determining contribution to the data changes for the studied time interval. Temporal changes of trend in V described by non-stationary harmonic at T~54 yr shows decreasing of V since ~1982 and for now, but V will be increasing since ~2010. This trend shows 50% rise of V for the period 1963-1982. The IMF trend extracted from the data by self-consistent method and described by stationary sinusoid with T=(1985) yr shows 1.5 increasing of the IMF value for the interval 1963-1990 (45% rise in the IMF strength over the period). The IMF value decreases at present since its maximum at~1990. These slowest changes in values of the IMF and in the solar wind velocity V (trends) can explain ~95% changes of trend in aa index of geomagnetic activity for the period 1963-1997 discussed by scientific community (Stamper et al, 1999).

Keywords: sun, imf, solar wind velocity

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ASII017 **Oral Presentation** **3291**

Using Topside Sounder Electron-Density Profiles to Investigate Mid-latitude Variations in the Ionospheric O+/H+ Transition Height

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A better knowledge of the mid-latitude F-region is needed to mitigate the ionospheric impacts on advanced technological systems, such as GPS positioning, where electron-density (Ne) irregularities are often the limiting factor of overall performance of systems based on trans-ionospheric radio propagation. The mid-latitude transition height (where the O+ and H+ number densities are equal) is of importance because it is where the topside altitude distribution of the dominant ions transitions from the ionospheric F region into the plasmasphere which is considered the inner region of the magnetosphere. The O+/H+ transition height can be determined by fitting ionospheric-topside-sounder-derived Ne profiles to analytical O+ and H+ functions. We used ~ 160,000 separate Ne profiles from the height of the ionospheric Ne maximum up to an altitude of ~ 3,000 km deduced from Alouette and ISIS (International Satellites for Ionospheric Studies) topside-sounder data. These data, available over two decades starting from 1962, have been used to investigate variations in the topside Ne profiles to diurnal and seasonal changes as well as changes in solar-activity and geomagnetic activity.

Keywords: electron density, ionosphere, topside

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ASII017 **Oral Presentation** **3292**

AE geomagnetic index predictability for highly alfvenic solar wind streams.

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High intense, long duration, continuous AE activity (HILDCAA) events are usually observed during the passage by Earth of high speeed streams. During these events, the AE index exhibits high activity for more than two days, with peak values over 1000 nT. The AE values never drop below 200 nT for more than two consecutive hours, and must occur outside the main phase of geomagnetic storms. The occurrence of these phenomena in the Earths magnetosphere/high latitude ionosphere is associated with the presence of high amplitude Alfvn waves in high speed streams. In this study we have applied a wavelet interactive filtering and reconstruction technique on the solar wind magnetic field components and AE index series which allowed us to find a relationship between them. The Bz component was found as the most significant solar wind parameter responsible by the control of the AE activity. Assuming the reconnection associated to southward directed Bz as the main mechanism transferring energy into the magnetosphere, we adjusted parameters to forecast the AE index. The adjusted routine is able to forecast AE, based only on the Bz measured at the L1 Lagrangian point. This will give us a prediction ~30-70 minutes in advance of the actual geomagnetic activity. The correlation coefficient between the observed AE data and the forecasted series reached values higher than 0.90. In some cases the forecast reproduced particularities observed in the signal very well. The high correlation values observed and the high efficacy of the forecasting can be taken as a confirmation of the hypothesis that reconnection is the main physical mechanism responsible for the energy transfer during HILDCAAs.

Keywords: ae index, alfven waves, forecasting

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ASII017 **Oral Presentation** **3293**

Bashful Ballerina: The Asymmetric Sun viewed from the Heliosphere

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Long-term observations of the heliospheric magnetic field (HMF) observed at 1 AU have shown (1) that the HMF sector coming from the northern solar hemisphere systematically dominates in the late declining to minimum phase of the solar cycle. This leads to a persistent southward shift or coning of the heliospheric current sheet at these times that has been picturesquely described by the concept of the Bashful Ballerina. This result has recently been verified by direct measurements of the solar magnetic field for the last three solar cycles (2). The average field intensity is smaller and the corresponding area is larger in the northern (heliographic) hemisphere than in the southern hemisphere. Long-term observations of the Earths magnetic field can yield information on the HMF sector structure. These observations show that the Ballerina was Bashful since 1920s (3). Moreover, it has been shown that the global HMF has persistent active longitudes whose dominance depicts an oscillation with a period of about 3.2 years. Stellar observations show that this seems to be a general pattern for sun-like cool stars. We describe these phenomena and discuss their implications.(1) K. Mursula, and T. Hiltula,Geophys. Res. Lett. 30 (22), p. SSC 2--1-4, doi: 10.1029/2003G L018201, 2003.(2) Zhao, X.-P., J. T. Hoeksema, and P. H. Scherrer, J. Geophys. Res., 110, A10101, doi:10.1029/2004JA010723, 2005.(3) T. Hiltula, and K. Mursula, Geophys. Res. Lett., 33 , L03105, doi:10.1029/2005GL025198, 2006.

Keywords: solar asymmetries

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ASII017 **Oral Presentation** **3294**

Toward understanding the ionosphere and thermosphere: the need for coordinated ground- and space-based measurements

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The Earth's upper atmosphere has been explored by ground-based measurements of a variety of types for nearly a century. From the dawn of the Space Age, the upper atmosphere has been the focus of a variety of measurement activities. Yet we still lack a true understanding of many of the drivers and the phenomena that occur in the upper atmosphere. This lack of understanding is sometimes obscured by parameterizations and empirical models of the boundary conditions of the models. Models, both first principles and empirical give us insight into the broad-brush picture of the processes at work in the upper atmosphere. One should not forget, however, that the ability to predict based on an empirical model or the assimilation of data does not imply understanding. To develop a true understanding, and to check that understanding, we need a wide range of instruments and techniques. The possibility of the development and distribution of large numbers of relatively inexpensive instruments offers the promise of globally distributed measurements of important parameters. New extensively instrumented sites such as the US AMISR program will provide flexible and definitive measurements but with a limited geographic distribution. Small satellites offer promise but the smallest and cheapest of these satellites do not have the power, volume, pointing accuracy, and/or data rate necessary to support many of the space-based instruments that have formed the foundation for continuous observations of the ionosphere/thermosphere (I/T). As more nations launch their own satellites, they naturally turn to the I/T as the I/T is arguably the region of the geospace with the greatest technological impact: important measurements of the I/T can be made with relatively simple and relatively inexpensive instruments. The I/T community must develop an integrated, global measurement strategy in order to make the most timely and cost-effective use of the resources and the lessons learned that are available to us. This talk will explore developments aimed at establishing that strategy.

Keywords: ionosphere thermosphere, remote sensing in situ, experimental techniquessate

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ASII017 **Poster presentation** **3295**

Quasi-Real Time Derivation of TEC and its Application for Space Weather Monitoring

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A permanent monitoring of the ionospheric state is an essential part of space weather monitoring and forecast. The world-wide use of global navigation satellite system such as GPS offers the unique chance for a permanent monitoring of the total electron content (TEC) of the ionosphere and plasmasphere up to about 20000km height. We have developed a system of prompt derivation of TEC from GEONET data and use the TEC distribution over Japan in our daily operation of Space Weather Forecast Center at NICT (RWC Tokyo of ISES). The latest TEC values are obtained every 3 hours with a delay of about an hour due to data processing. We have found it quite powerful for monitoring progress and extent of ionospheric storms continuously under any ionospheric conditions even when the usual ionosonde observation is incapable to obtain F-region profiles.

Keywords: tec, space weather monitoring, ionospheric storms

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ASII017 **Poster presentation** **3296**

Study of the auroral emissions and electron precipitation at low sun activity

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Simultaneous observations of the OI 5577 Å and 6300 Å emissions, the electron precipitation, the terrestrial magnetic field and the plasma parameters, and the corresponding solar wind, Interplanetary Magnetic Field and geomagnetic activity indices data near the Solar cycle minimum have been used in order to study the Sun-Earth interactions under quiet conditions. Images of 5577 and 6300 emissions have been obtained from the All-Sky Imager (ASI), positioned at ARR, Andenes (69.3N, 16.03E). The Imaging Riometer for Ionospheric Studies (IRIS), at Kilpisjrvi, Finland (69.05N, 20.79E) gave information about the precipitating electrons with energies in the range 10x100keV and deposition heights centered at about 90 km. The magnetic field components have been measured by the Andenes magnetometer (69.3N, 16.03E). The essential ionosphere parameters have been acquired from the measurements of the Digisonde, situated at Troms (69.6N, 19.2E). A good correlation between the spatial and temporal evolutions of the optical emissions, the precipitating electron fluxes and the terrestrial magnetic field has been observed. The response of the ionosphere to the solar and geomagnetic activity changes has been studied. The study was performed under a project, part from the ALOMAR eARI Project, EUs 6th Framework Programme, Andenes, Norway.

Keywords: aurora, particle precipitation, quiet conditions

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ASII017 **Poster presentation** **3297**

Ionosphere transfer characteristic for radio astronomical signals and space weather impact as deduced from two-frequency GPS radiosounding and IRI-2001 modeling

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Continuous improvements of VHF radio telescopes have been made due to growing scientific and applied importance to radio astronomy. VHF signals are widely used for observations of the sun and pulsars. Nowadays huge low-frequency radio astronomical arrays (LOFAR, 30-240 MHz; MIRA, 80-300 MHz) are being constructed to record pulsar radiation at maximum possible distance. Registration of solar radio emission intensity at fixed frequencies and in spectral VHF band is very important along with other methods of monitoring of coronal mass ejections. In order to extend the dimension of observable solar radio corona they endeavor to use maximum permissible low frequencies of VHF band. At the interpretation of the ground based radio telescopes data it is necessary take into account the possible distortions of radio astronomical signals at the Earth ionosphere. However in contrast to modern radar and navigation systems (GPS, GLONASS, GALILEO), where very accurate reconstruction of ionosphere parameters is a built-in function, in present-day radio astronomy a retrieve of ionosphere transfer characteristics has not been appropriately worked out yet. We have developed a method and software for calculation of the ionosphere measure of rotation RM, and the measure of dispersion DM for specific experimental and space weather conditions. We used the ionosphere model IRI-2001, magnetic field model IGRF-10 and values of ionosphere total electron content as deduced from GPS and satellite altimeter measurements. The obtained values of the ionosphere DM and RM were recalculated into characteristics of phase delay, Faraday amplitude modulation, spectrum distortion and polarization changes. We proposed the relevant method of ionosphere corrections permitting to reconstruct the initial parameters of radio astronomical signals (before ionosphere). In the paper we made calculations for different levels of geomagnetic and solar activity. On the examples of radio telescopes LOFAR and MIRA we examined dependence on location of radio telescope and on angular position of radio sources as well.

Keywords: ionosphere, gps, radio astronomy

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ASII017 **Poster presentation** **3298**

Analysis on coronal holes and high-speed solar wind during solar minimum

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Kazuyuki Hakamada

It enables a study on coronal holes that continuous long-term observations by the SXT (Soft X-ray Telescope) on board Yohkoh and the EIT (Extreme ultraviolet Imaging Telescope) on board SOHO . And there is continuous in-situ solar wind observation by ACE. We studied on coronal holes and high-speed solar wind during solar minims of cycle 22 and 23. We found that high- speed solar wind was often observed without a clear signature of coronal holes during the solar minimums. Recurrent patterns of high-speed solar wind became unclear during solar minimum in contrast with the declining phase. Sources of high-speed solar wind during solar minimum were analyzed using the source surface model.

Keywords: coronal hole, solar wind

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ASII017 **Poster presentation** **3299**

Influence of space weather on cardio system of health people: results of telecommunication experiment

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One of the central problems of helio-biology is very limited possibilities to obtain objective experimental data adequately reflecting the common totality of all human population. At the present time, the increase of objectivity understanding of space weather influence on biological processes is possible only through monitoring of constant groups over the world and telecommunication network creation. Results of the first synchronous biophysical experiment Heliomed (since 2006, http: www.geliomed.kiev.ua) for estimation of solar and geomagnetic activity influence on functional state of people are presented. The informational telemedical technology is used in this experiment on the base of original telecommunication cardiomonitor usage, possessing of cardio data for three constant group in Moscow , Kiev and Yakutsk . We expect to obtain sufficient experimental purity for the extent of effect of endogenous and exogenous stress-factors at different places simultaneously using the standard equipment taking into account ethnic peculiarities and differences in the environmental factors.

Keywords: space weather, health

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ASII017 **Poster presentation** **3300**

The first space weather forecast models from the center for integrated space weather modeling

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One main objective of the Center for Integrated Space Weather Modeling (CISM) is to develop forecast models (FM) for the Sun-Earth chain, and to mature them close to the operational stage. The Sun-Earth chain comprises empirical and physical models. Among the former is the Planetary Equivalent Amplitude FM with a 1 to 7 day prediction of the daily Ap and a 3 to 24 hour prediction of the running 3 hourly ap. We employ a linear filter technique which is driven by real-time ACE solar wind speed and AFWA Ap/ap data. Among the latter is the Ambient Solar Wind FM with a 1 to 5 day prediction of solar wind parameters in 6 hour intervals. It is driven by daily NSO/SOLIS synoptic maps. We employ the Wang-Sheeley-Arge algorithm to transform these into inner boundary conditions for the ideal MHD code ENLIL, which propagates the solar wind structures out to Earth and beyond. We are also preparing a Geospace FM with short-range predictions for magnetospheric and ionospheric parameters, which is driven by real-time ACE measurements. The transition from science to forecast model follows along these main steps: the science model is validated against various metrics, software engineering matures the transition candidate, and useful forecast products are derived from the forecast model.

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ASII017 **Poster presentation** **3301**

The influence of dipole tilts on plasma parameters inside the magnetosphere using two-dimensional MHD simulations

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The interaction between the solar wind and planetary magnetospheres is not easily understood just from the measurements, limited by spacecrafts trajectories. Global magnetohidrodynamic (MHD) models, developed to solve for the magnetospheric configuration and to provide a self-consistent picture of the solar wind-magnetosphere interaction process, has been successful used for the past decades. The MHD theory deals with the macroscopic energy conversion governing the global configuration, that is, the physical processes involved in the conversion among the magnetic, kinetic and thermal energy. In this work, we present results we have obtained with a modified version of the two-dimensional MHD code of T. Ogino (Ogino et al, Journal of Geophysical Research, v. 91, p. 6791, 1986). The modifications have been made in order to include inclination to the dipolar axis. Additionally, the box simulation was increased and the boundary conditions have been changed. Our goal was to investigate the formation of the magnetosphere for different dipole tilts and different conditions for the interplanetary magnetic field (IMF). In order to assure the modifications were well implemented, we run the code considering a null IMF and three different values of inclination: 0, 45 and 90. The obtained results are in good agreement with the ones presented by Wu (Wu, Journal of Geophysical Research, v.89, p. 11048, 1984) for the same conditions. We also present results that were obtained with initial conditions considering northward and southward IMF, for the three values of dipole tilt. The time evolution of plasma parameters (current and pressure) at the magnetosphere are presented. Particular attention is given to the time evolution of pressure and density in selected points at the dipole axis and Sun-Earth line.

Keywords: mhd, dipole tilt, magnetosphere

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ASII017 **Poster presentation** **3302**

Influence of space weather changes on human health state

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Space weather can have deleterious effects not only on technological systems as well as biological and ecological systems. Study and understanding the physical links between space weather sources and short- and long-term effects on human health at different geomagnetic latitudes will be invaluable, especially for mitigation and preventive measures.For getting more and better knowledge about solar and geomagnetic storms potential effects on human life and health, particularly in mid-latitudes, we are conducting relevant investigations in the as a part of collaborative study. The experiment is based on a method of measurements of electrical conductivity of biologically active (acupunctural) points of human skin which characterize the functional condition of proper organs in human body. Measurements were carried out on a daily base with permanent group (11 persons) of functionally healthy persons in the Laboratory of Heliobiology, Medical Center INAM. Daily monitoring and analyses of space weather (parameters of solar, geomagnetic and cosmic ray activities) as well as meteorological (temperature, atmospheric pressure, humidity, wind speed, etc.) conditions were conducted. In order to avoid possible subjective psychological influence upon participants, they were not familiarized with space weather conditions in advance.Experiments correspond to the period of economical and societal stability in the country and cover descending phase of the solar activity cycle 23 and is therefore is quite interesting. In parallel, electrocardiograph investigations were conducted as well. Digital data was subjected to relevant mathematical and statistical analysis. Results of experimental investigations on possible influence of solar and geomagnetic storms of various strengths on thehuman health state are described and compared with ones obtained in different cities located in different latitude and longitudes but performed with the same method and devices. Theory of parametric resonance in biological systems is used for explanation of some results. Comparison with results of other investigators and other methods is given.

Keywords: space weather, people health

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ASII017 **Poster presentation** **3303**

Study of the fast forward shock propagation in the Earth's vicinity

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The interplanetary shocks observed in the solar wind interact with the Earth'sbow shock and cause pressure pulses on the magnetopause and its movement. Eventually, they launch different types of waves into the magnetosphere.Using a set of fast forward shock observations from 1995 till 2006 years with different solar wind parameters we try to outline their propagation into the Earth's magnetosphere.The shocks were recorded in the solar wind simultaneously by several satellites asACE, Wind, IMP-8, SOHO, Genesis, Interball-1, Geotail, and Cluster, so their basic parameters could be well evaluated. Further in the Earth's magnetosphere, we used suitable data from Geotail, Polar, Cluster,Interball-1, and GOES series satellites.The aims of our study are comparison and tracing of propagation velocities of observed disturbances indifferent parts of the dayside and near-Earth's magnetosphere, depending on the orientation of the interplanetary shock normal. Also, we will try to explain observed structuring of the shock disturbance fronts in the high-time-resolution magnetospheric data.According to our results, the shock speeds are significantly higher in the Earth's magnetosphere, especially more closely to the Earth, than in the solar wind and propagation times vary even in different places ofthe dayside magnetosphere. Suggested deformation of the shock front inside the Earth's magnetosphere is compared with available global MHD models.

Keywords: interplanetary shock, earths magnetosphere

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ASII017 **Poster presentation** **3304**

Solar activity imprint on Mesozoic Gondwana tree rings

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Evidences of the solar activity modulation of the Earths climate have been observed from decadal to millennial time scales. Although several mechanisms have been proposed to explain these observations, the link remains unclear. Several proxies have been used to reconstruct the paleoclimate as well as the solar activity. The climate reconstructions are based on direct and/or indirect effects of global and regional climate conditions. The solar activity reconstructions are based on the production of the 14C isotope due to the interaction of cosmic rays flux and the Earths atmosphere. As trees respond to climate conditions and store 14C, they have been used as proxies both for climate and solar activity reconstructions. The imprint of solar activity cycles has been observed on tree-ring samples 10.000 years ago using 14C data and 20 millions ago using fossil tree-growth rings. However, the solar activity imprint on tree-rings during the Mesozoic Era (200 million years ago) was not yet investigated. In this work we show that tree-rings from the Mesozoic Era registered the 11-year (Schwabe Cycle) and the 22-year (Hale Cycle) solar activity cycles, with a significance of 95%. The fossil wood were collected in the So Pedro do Sul (Lat. ~29o40S, Lon. ~54o10W) and Mata sites (Lat. ~29o35S, Lon. ~54o27W). Their series power spectra showed characteristics similar to the modern araucaria trees, with a noticeable decadal periodicity. Based on solar activity interpretation as the plausible origin of this cycle, we concluded that the 11 year solar cycle and a solar-climate relationship existed during the Triassic period.

Keywords: sun terrestrial relationships, solar activity, tree rings data

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ASII017 **Poster presentation** **3305**

SEP/X-flare relation with GLE events during solar cycle 23

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The study of solar relativistic particle events deserves special attention because of their impact on the Sun-Earth system. Hence, a systematic analysis of GOES proton and X-ray data during the on going solar activity cycle is performed to draw the characteristics of the solar particle emission (SEP) when ground level enhancements (GLE) are recorded by the world wide neutron monitor network. Some specific features are identified and discussed in terms of a possible GLE forecast.

Keywords: gle, sep, x ray

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ASII017 **Poster presentation** **3306**

Solar and Interplanetary Causes of High-Intensity, Long Duration, Continuous AE Activity (HILDCAA) Events.

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The High-Intensity, Long-Duration, Continuous AE Activity (HILDCAA) events were first observed and defined in 1987 by Tsurutani and Gonzalez. These events are characterized by a continuously increased AE index activity lasting for more than 2 days. During these intervals, the AE index must reach a peak value of 1000 nT and the index value must not fall below 200 nT for intervals longer than 2 hours at a time. Also, the event must occur outside the main phase of a geomagnetic storm. In this work, 14 HILDCAA events occurred from 1998 to 2001 were identified using ACE plasma and magnetic field data, and geomagnetic indices (AE and Dst). All these events were associated with solar wind velocity increases in the interplanetary medium. For 12 out of 14 events, these velocity increases were clearly due to the passage of high speed solar wind streams (the interplanetary structures associated to the two remaining events are not clear). Using solar wind and magnetic field data during these streams, we have computed correlation coefficients among the high resolution components and we have found that the magnetic fluctuations observed have an Alfvenic nature. The solar cause of each high speed stream was analyzed using daily solar corona maps and also maps constructed along a whole Carrington rotation (from Kitt Peak Observatory). By taking the solar wind speed observed with ACE, we computed the time when the high speed stream was emitted from the sun and tried to identify the most plausible coronal hole source. For 12 out of 14 events, it was possible to find at least one possible coronal hole related to the increase in the solar wind speed in the interplanetary medium.

Keywords: hildcaa, alfven waves, coronal holes

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ASIII018 **3307 - 3345**

Symposium
Magnetopause and magnetosheath processes: reconnection, diffusion and boundary dynamics (Divisions III and IV)

Convener : Dr. Christopher Owen

The magnetopause and its boundary layers are the prime sites of mass, momentum and energy transfer from the solar wind into the magnetosphere. The physics of these processes are therefore of central importance to magnetospheric physics. Observations of these regions continue to be returned from spacecraft missions. These observations are further supported by observations from ground based observatories. New progress in simulations, MHD, hybrid and kinetic, and theoretical advances allow the physics of reconnection and boundary layer processes to be elucidated as never before. This symposium invites contributions on a wide range of magnetopause related topics, including observations of the structure of the magnetopause current layer, its boundary layers and their transient variations, the signatures of the various forms of plasma interactions, such as magnetic reconnection, at the magnetopause and their relevance to solar wind magnetosphere coupling, and the interaction of solar wind disturbances with the magnetosphere. The basic physics of reconnection, plasma diffusion and boundary layer formation at the magnetopause and magnetosheath processes influence magnetopause dynamics are also highly relevant. Multi-spacecraft and/or ground based observations which relate the magnetopause signatures to phenomena observed inside the magnetosphere or in the ionosphere are particularly welcome, as are modelling and simulation studies which complement the observations.

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ASIII018 **Oral Presentation** **3307**

A Nearly Universal Solar-Wind Magnetosphere Coupling Function

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We investigated whether one or a few coupling functions can represent best the interaction between the solar wind and the magnetosphere, over a wide variety of magnetospheric activity. Ten variables which characterize the state of the magnetosphere were studied. Five indices from ground-based magnetometers were selected, namely Dst, Kp, AE, AU, and AL, and five from other sources, namely auroral power (Polar UVI), cusp latitude (sin(tc)) and b2i (both DMSP), geosynchronous magnetic inclination angle (GOES), and polar cap size (SuperDARN). These indices were correlated with more than 20 candidate solar wind coupling functions. One function, representing the rate magnetic flux is opened at the magnetopause, correlated best with 9 out of 10 indices of magnetospheric activity. This is dFMP/dt = v^4/3BT^2/3sin^8/3(tc/2), calculated from (rate magnetic flux approaches the magnetopause, ~vBT)(% of IMF lines which merge, sin^8/3(tc/2))(merging line length, ~(Bmp/BT)^1/3, with BMP~v). The merging line length is similar to a superposed IMF on a vacuum dipole. The IMF clock angle dependence matches the merging rate reported (albeit with limited statistics) at high altitude. The non-linearities of the magnetospheric response to BT and v are evident when the mean values of indices are plotted, in scatter plots, and in the superior correlations from dFMP/dt. Our results show that a wide variety of magnetospheric phenomena can be predicted with reasonable accuracy (r > 0.80 in several cases) ab initio, that is without the time history of the target index, by a single function, estimating the dayside merging rate.

Keywords: merging, coupling

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ASIII018 **Oral Presentation** **3308**

The Gumics MHD model supports pressure-dependent component reconnection on the magnetopause

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Global MHD simulation models are the present-day standard choice for modelling the entire magnetosphere and solar windmagnetosphereionosphere coupling self-consistently. A key process in this coupling is magnetic reconnection. In this study we present results on magnetopause reconnection processes in the Gumics-4 global MHD simulation model. The global separator line on the magnetopause is identified using a topological method. It is continuous and crosses the dayside magnetopause through the subsolar point. Strong dissipation of magnetic energy at the separator allows identifying it as the reconnection line. The orientation of the reconnection line depends on the IMF clock angle in a manner that is consistent with the component reconnection hypothesis. The overall reconnection efficiency is quantified by reconnection power, an integral of magnetic energy dissipation at the magnetopause. It shows an approximate sin4(θ/2) dependence on the IMF clock angle. Magnetopause reconnection efficiency in Gumics-4 is also strongly dependent on the solar wind dynamic pressure, and the speed of the solar wind is a more influential factor than its density.

Keywords: reconnection, magnetopause, simulation

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ASIII018 **Oral Presentation** **3309**

Plasma transfer across the magnetopause under northward interplanetary magnetic field: observational evidence by Cluster

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M. F. Marcucci, A. Retino, G. Pallocchia, H. Reme, E. Lucek

Under northward interplanetary magnetic field (IMF), magnetic reconnection is less efficient than under southward IMF, however plasma transfer across the magnetopause can still occur. In this geometry, the processes which are believed to contribute to the solar wind penetration in the magnetosphere are magnetic reconnection tailward of the cusp and Kelvin-Helmholtz instability (KHI). We will present a few cases of northward IMF in which Cluster shows observational evidence of plasma transport across the magnetopause, and will determine the efficiency of the corresponding transmission process as a function of magnetosheath parameters.

Keywords: magnetopause, reconnection

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ASIII018 **Oral Presentation** **3310**

Kelvin-Helmholtz instability in the magnetopause boundary layer: Recent advances

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We present recent advances in simulation as well as data analysis studies of the Kelvin-Helmholtz instability (KHI) in the magnetopause boundary layer, a potential mediator for efficient transport of solar wind plasma into the magnetosphere under northward IMF conditions. Based on 3D MHD simulations of the KHI conducted under various conditions, we show (1) that capturing of solar wind plasmas onto a closed portion of magnetospheric field lines can occur through KHI-induced magnetic reconnection, (2) that a very large-scale vortex could be generated quickly, when the KHI can grow spatially rather than temporally, and (3) that a 3D instability triggered in rolled-up vortices can play a role in energy transport from the boundary layer into the ionosphere. Recent findings from in-depth analyses of Cluster and Geotail data, combined with simulation results, are that (4) vortices can roll up in both dawn and dusk flanks of the magnetotail for northward IMF periods, (5) that a current sheet with thickness comparable to ion inertia length can be formed at the edge of rolled-up vortices, and (6) that reconnection can occur in the vortex-embedded thin current sheet, allowing the transfer of solar wind plasmas to the magnetosphere. Also presented is (7) Grad-Shafranov reconstruction of streamlines (2D vortex structure) in the flank low-latitude boundary layer from Geotail observations.

Keywords: magnetopause, kelvin helmholtz instability, plasma transport

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ASIII018 **Oral Presentation** **3311**

Optical, radar and magnetic observations of the magnetosheath plasma capturing during the positive impulse in IMF Bz-component

Dr. Vladimir Safargaleev

Alexander Kozlovsky, Tima Sergienko, Tim Yeoman, Mikhail Uspensky, Darren Wright, Hans Nilsson, Tauno Turunen

We present the multi-instrument study of ionospheric response to IMF turning northward. The observations were made in the near-noon (11 MLT) sector on Svalbard (at 75 MLAT). The data set includes auroral observations, ionospheric flows obtained from EISCAT and CUTLASS radars, spectral width of the HF radar backscatter, particle precipitation and plasma flow data from the DMSP F13 satellite, and Pc1 frequency band pulsations observed by induction magnetometers. Careful collocation of all the observations has been made with the HF radar backscatter located by the ray-tracing procedure utilizing the elevation angle of signal arrival and the ionospheric plasma density profile. Prior the IMF turning to northward, three auroral arcs existed at the poleward boundary of closed llbl, inside the llbl, and in the equatorward part of the llbl, respectively. The northward IMF turning was accompanied by the enhanced HF radar return with broad Doppler spectrum collocated with the arcs. Auroral arcs shifted poleward whereas the backscatter region moved in opposite direction which is consistent, respectively, with reconnection beyond the cusp and capturing the magnetosheath plasma during the northward IMF. Magnetic noise enhancement in the Pc1 frequency band occurred simultaneously with the anomalous radar backscatter, and the absence of signal at remote magnetic observatories indicates local generation of the Pc1 turbulence collocated with the radar backscatter. Finally, we discuss possible interpretation mistakes which may be caused by lucking observational data.

Keywords: dayside reconnection, plasma capturing, ionospheric signatures

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ASIII018 **Oral Presentation** **3312**

FTE generation for dominant IMF By: A case study and predictions of hemispheric asymmetry

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John Dorelli

Flux Transfer Events (FTEs) are a manifestation of time dependent magnetic reconnection at the magnetopause. How this reconnection process is controlled and how it depends on geophysical parameters is still much debated. In this talk we first present results from an OpenGGCM* simulation of the May 8, 2004 Cluster/Doublestar FTE event, which the simulation reproduces remakably well. A surprising result of the simulation is that the FTEs only occur on the dawn side, where they are observed, but none in the dusk side. This result contradicts virtually all previous FTE models which predict that the appearance of FTEs is symmetric around the sub-solar point. We show that the dipole tilt, together with the sign of the IMF By determine in which hemisphere FTEs occur.

Keywords: fte, magnetopause, reconnection

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ASIII018 **Oral Presentation** **3313**

Transport at the Magnetopause due to Nonlinear Interaction with Low Frequency Waves

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Simon Wing, Yu Lin

The magnetopause and boundary layer are typically characterized by large amplitude transverse ULF wave activity with frequencies below the ion cyclotron frequency. The wave properties are consistent with a mode conversion process that couples large-scale surface MHD fluctuations with kinetic Alfven waves at the magnetopause boundary. We model the waves with theory and global three-dimensional hybrid simulations. We find that ions and electrons can interact nonlinearly with these waves leading to perpendicular heating of ions, parallel heating of electrons, and plasma transport across the magnetopause boundary. Several observational constraints for plasma entry have been recently reported [Wing et al., J. Geophys. Res., A08205, 2005]. In situ GEOTAIL particle observations and remote observations of plasma along the magnetotail flanks inferred using DMSP indicate that during prolonged periods of northward IMF a dawn-dusk asymmetry in the global density and temperature profiles develops in the plasma sheet. Plasma filling rates can also be estimated from both in situ and remote observations. We discuss the time scale for the filling of the plasma sheet as well as possible causes for the dawn-dusk asymmetries in the context of particle entry mechanisms such as cusp reconnection, Kelvin-Helmholtz instabilities, and kinetic Alfven waves.

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ASIII018 **Oral Presentation** **3314**

On the formation of 3-D fine magnetic structures at the magnetopause

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Philippe Louarn, Elena Budnik, Andrei Fedorov, Jean-Andr Sauvaud, Elizabeth Lucek, Christopher Owen, Pierrette Decrau, Nicole Cornilleau-Wehrlin

Louarn et al, (2004) have reported Cluster observation made on June, 30, 2001, concerning the formation of 3D complex structures at the magnetopause. These structures appear to be consistent with a model of inter-linking flux tubes resulting from patchy reconnection. We propose an extended investigation of these phenomena, based on the analysis of further events observed with different inter-satellite distances and using a more complete set of Cluster data. Emphasis will be put on the determination of the magnetic topology of the structure, the investigation of the transformations undergone by the distribution functions and the possible associated wave/particle interaction processes.

Keywords: magnetopause, reconnexion, cluster

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ASIII018 **Oral Presentation** **3315**

Joint dynamics of the Earths magnetopause and bow shock boundaries: Prognoz/Interball observations and model comparison

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Observations of the terrestrial magnetopause and the bow shock by the Prognoz/Interball orbiters in the period of 1972 - 2000 are analyzed to study joint dynamics of these boundaries under different solar wind conditions: ram pressure, Bz component of the interplanetary magnetic field (IMF), sonic and Alfvenic Mach numbers, and the angle between plasma velocity and IMF vectors. Analytical models of the magnetopause and bow shock motion are used as a base for the investigation. Revealed systematic deviations of the observed from the modeled boundary positions are analyzed. These deviations are interpreted in terms of the basic physical processes at different bow shock and magnetopause parts. This work was partially supported by Programs P16/2 and OFN 16 of Russian Academy of Sciences.

Keywords: bow shock, magnetopause, satellite observations

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ASIII018 **Oral Presentation** **3316**

Determining the rate and location of magnetopause reconnection from observations of the ionosphere

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Suzanne M. Imber, Gabrielle Provan, Benoit Hubert

Magnetic reconnection at the magnetopause is fundamental for determining the shape, structure, and dynamics of the magnetosphere. The rate of magnetic reconnection and its location on the magnetopause are both important in determining the magnetospheric response to the driving. Due to their localized nature, in situ measurements are not able to measure the overall reconnection rate or the magnetic topology of the field lines undergoing reconnection. These can, however, be determined from observations of the ionosphere by auroral imagers and ionospheric radars, which can provide an almost global view of the reconnection process. We present a brief review of recent advances in our understanding of the location, rate, and influence of reconnection gained from ionospheric observations, including low latitude, single lobe, and dual lobe reconnection.

Keywords: magnetic reconnection, magnetopause

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ASIII018 **Oral Presentation** **3317**

The Magnetospheric Low-Latitude Boundary Layer and Cusp Dynamics during Interplanetary Coronal Mass Ejection Events

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C.J. Owen, G. Siscoe, O. Marghitu, I. Dandouras, Z. Kaymaz, H. Reme, E.A. Lucek, A.N. Fazakerley

We present a study of the plasma properties and dynamics of the Low-Latitude Boundary Layer (LLBL)/cusp during the Interplanetary Coronal Mass Ejection (ICME) event on 07th November 2004 based on data from the four Cluster spacecraft. The interplanetary magnetic field (IMF) is predominantly strongly northward, up to 50 nT, with some short-duration rotations. The observed LLBL/cusp is very thick (~6-7 deg invariant latitude (ILAT)) and migrates equatorward with rates of 0.55 deg and 0.04 deg ILAT per minute during quick southward IMF rotations and stable northward IMF respectively. The LLBL/cusp observed by Cluster 1 and Cluster 4 is in a fast transition between different states and is populated by different types of plasma injections, presumably coming from multiple reconnection sites. During a period of extremely northward IMF, signatures of dual reconnection inside the LLBL/cusp are observed by Cluster 3, suggesting that at least part of the LLBL/cusp is on closed field lines. However, analysis of the ion data implies that the boundary layer is formed in the dawn sector of the magnetosphere, and does not slowly convect from the dayside as has been suggested previously. A statistical study of the location of the LLBL/cusp equatorward boundary during the ICME events on 28-29 October 2003 and 7-10 November 2004 is performed. During extreme conditions the LLBL/cusp position is off-set by -7 deg ILAT from the location expected under normal conditions, which might be explained by the influence of the high solar wind dynamic pressure. The LLBL/cusp moves equatorward with increasing southward and northward IMF. However, the LLBL/cusp position under strong southward IMF is more poleward than expected from previous studies, which could indicate some saturation in the dayside reconnection process or enhancement of the nightside reconnection rate. The LLBL/cusp position under strong northward IMF is extremely low and does not agree with the location predicted in previous studies. For events with solar wind dynamic pressure > 10 nPa, the LLBL/cusp position does not depend on the solar wind dynamic pressure. This might indicate some saturation in the mechanism controlling the LLBL/cusp location for large solar wind dynamic pressure.

Keywords: reconnection, boundary, layer

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ASIII018 **Oral Presentation** **3318**

Plasma separation near magnetopause: evidence for Alfvenic collapse

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Evgenii A. Kuznetsov, Ermanno Amata, Malcolm Dunlop, Vincent Genot, Yuri Khotyaintsev, Joerg Buechner, Eugenyi Panov, Jan Blecki, Alexandr Skalsky

Alfvenic collapse has been recently proposed as a mechanism for the magnetic barrier growing between plasma regions in relative motion with 3D features. In MHD limit it predicts infinite field rising due to magnetic field-line breaking (or piling-up). Both Cluster and Interball case and statistical data demonstrate regular detection of thin barriers with dominant magnetic pressure over the rest ones and 3D features of the transverse flow. The ratio of electric to magnetic disturbance amplitudes is close to Alfven speed, the magnetic disturbances are transverse to the electric ones and to the background magnetic field. The latter conforms to the Alfvenic nature of the process. We display a Cluster case, clearly showing the barrier growth and thinning until reaching the scale of proton gyroradius and dominating magnetic pressure in the surrounding high-beta plasma. We account for the barrier minimal scale of the order of ion gyroradius, regularly seen by Interball and Cluster, by the collapse termination due to compensation of the magnetic field concentration into the rising |B| regions by its backward finite-gyroradius diffusion. The resulting equilibrium is predicted and seen to be supported by the transverse plasma flow at nearly ion thermal speed. The interface between flowing and stagnant boundary layers has inside the dominant magnetic pressure, it can be seen for more than half an hour at distances of about 1 Re, but its highly variable fine stricture looses correlation at few thousand km. We discuss how the magnetic barriers provide the plasma separation, energization and acceleration, including the plasma jets with extremely high ram pressure, registered by Cluster, Interball, Polar and Geotail, which often are not accounted for a reconnection. Globally the magnetic barriers look to be synchronized by resonant plasma oscillations between magnetopause and bow shock at frequencies 1-2 mHz. The field- line breaking is predicted to operate also in astrophysical and heliospheric plasma flows with the divergent transverse velocity, e.g. at the convection cell boundaries on the Sun. Intercomparison of the theory, modeling, experiment examples and statistics points out that the Alfvenic collapse is a promising mechanism for the magnetic field generation and plasma separation in the Universe. This work was supported by ISSI and INTAS grants 03-50-4872 and 05-1000008-8050

Keywords: alfvenic collapse, magnetic barriers, boundary support transport

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ASIII018 **Oral Presentation** **3319**

Three-dimensional kinetic simulations of electron diffusion region

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There are now several observations of electron diffusion region in the magnetopause. The current sheets associated with the electron diffusion regions are typically a few kilometers wide, which is comparable to the electron skin depth. We have simulated the plasma processes occurring in such thin current sheets using fully three-dimensional particle-in-cell simulations and real ion to electron mass ratio M/m = 1836 for a hydrogen plasma. Simulations are done with and without a guide field. We find that shear-assisted Bunemaninstabiltyplays a strong role in the stability and structure of the current sheet. Theinstability disrupts the current in its central part and bifurcates the current sheet. The disruption is associated with large anomalous resitivity. The electrostatic fluctiations in the electric fields are spiky and are found to have sacle size as detected in the polar observations. In the presence of the guide fields, in-plane currents are generated, which introduce stuctures in the guide field. We compare such structures with those seen from Polar. The electromagnetic turbulence generates fast changing stair-case structures in the current distribution in the current sheet. The various processes in the current sheet are very effective in ion and electron acceleration. The latter (electrons) are accelerated to relativistc energies.

Keywords: electron, diffusion, region

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ASIII018 **Oral Presentation** **3320**

Evolution of Kelvin-Helmoltz Activity along the Dusk Flank Magnetopause from Two-point Distant Observations

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Our purpose is to characterise the evolution of the Kelvin-Helmoltz (KH) activity along the flank magnetopause, over the scales at which the disturbances proceed from the dayside to further down the tail. We examine whether the adjacent boundary layer, expected to form as a result of continued KH activity, is then subject to increased turbulence levels and whether it widens from the subsolar point towards the tail. We use two-point distant observations along the dusk flank magnetopause and at low latitudes, from GEOTAIL and CLUSTER, to quantify the intensification of the KH activity between the two sites, in a period of northward interplanetary magnetic field. GEOTAIL is on the dayside (15 MLT) while CLUSTER is tailward of the dusk terminator (19 MLT). We compare growth and power from magnetic field fluctuations as well as the thickness of the low latitude boundary layer. An estimate of the boundary layer thickness at each site is obtained by correlating normal distances to the magnetopause, derived from an empirical solar wind driven model, with a systematic relationship (the "transition parameter") found between the electron number density and the electron temperature at both sites. At the tailward site, the boundary layer supports longer wavelength and is thicker. This result demonstrates the efficiency of the KH instability as plasma transport mechanism.

Keywords: magnetopause, boundary layers, mhd waves and instabilities

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ASIII018 **Oral Presentation** **3321**

Observations of energetic O+ in the distant tail magnetosheath: results from stereo

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Two identical Plasma and Suprathermal Ion Composition (PLASTIC) instruments are now flying on the STEREO A and B observatories, which launched in October 2006. PLASTIC is a solar wind and heliospheric ion mass spectrometer that utilizes electrostatic deflection, post-acceleration, time-of-flight, energy, and position measurements in the energy-per-charge range of 0.25-80 keV/e. During the month of February, 2007, as the spacecraft were approaching their final heliocentric orbits, STEREO B traversed the dusk-side magnetosheath and boundary layer from -100 Re to -300 Re down the tail. Throughout the month, bursts of energetic O+ were observed in the magnetosheath. The energy of the O+ extended to the upper range of the instrument, 80 keV. The occurrence of O+ correlated with periods of high solar wind velocity. We will compare these observations with observations of O+ in the near-earth magnetosheath, as observed by CLUSTER, and discuss the possible source and transport paths for these ions.

Keywords: magnetosheath, oxygen, magnetotail

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ASIII018 **Oral Presentation** **3322**

Magnetic reconnection at the magnetopause and in the magnetosheath

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Alessandro Retin, Andris Vaivads

Magnetic reconnection leads to energy conversion in large vomumes of space but is initiated in small regions. We use observations by the four Cluster spacecraft to compare the microphysics of reconnection at the magnetopause with the recently discovered reconnetion in the turbulent plasma in the magnetosheath. At the magnetopause the reconnection X-line can beseveral earth radii, while in the magnetosheath the relevantstructures may be only a few hundred kilometres (an ion gyroradius).

Keywords: reconnection, magnetopause, magnetosheath

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ASIII018 **Oral Presentation** **3323**

Selected topics on reconnection in the magnetosheath and at the magnetopause

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We present a summary of recent studies related to the reconnection process in the magnetosheath and at the magnetopause. Particularly we concentrate on the microphysical aspects of these processes. We summarize the results due to the recent discovery of reconnection within the turbulent plasma of magnetosheath.We show how this affects the time development of the turbulent properties of the plasma, particularly its intermittency, and speculate on the astrophysical importance of these results. Then we discuss the microphysics of reconnection onset at the magnetopause, particularlythe role of drift-lower hybrid waves and the formation of magnetic islands. We also show the direct estimates of the energy transfer across the magnetopauseas obtained from Cluster measurements. Then we present the analysis of micro-physical structure of the separatrix region, particularly discussing the presence of narrow current sheets and the formation of strong electric fields across them. We speculate on the role these narrow currents sheets have in the mangetosphere/ionosphere coupling. Finally, we discuss how whistler wave observations can be used for the remote sensing of reconnection processesat the magnetopause.

Keywords: reconnection, magnetopause, magnetosheath

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ASIII018 **Oral Presentation** **3324**

Low frequency waves in the terrestrial magnetosheath observed by the Cluster satellites

Dr. Mariella Tatrallyay

Geza Erdos, Elisabeth Lucek, Iannis Dandouras, Edita Georgescu

The occurrence of mirror and ion cyclotron waves is studied in the terrestrial magnetosheath based on Cluster measurements. In the winter/spring season of 2006 and 2007, the separation of the Cluster spacecraft was over 10 thousand km, therefore the nature and properties of the field fluctuations could be simultaneously observed in different regions of the magnetosheath. The type of the wave activity is determined from the characteristics of the magnetic field variations. Locally measured plasma parameters are involved in the study to examine the correlation between field strength and plasma density as well as the mirror instability threshold. The ACE spacecraft provides the alpha/proton density ratio of the solar wind affecting the growth of mirror mode waves. A few orbits are selected where the evolution of the mirror and/or ion cyclotron waves can be traced from the bow shock to the magnetopause. It is analysed how interplanetary and local varations in plasma and field influence the occurrence of the two types of waves by comparing the simultaneous observations at distant locations.

Keywords: mirror mode waves, ion cyclotron waves, terrestrial magnetosheath

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ASIII018 **Oral Presentation** **3325**

The relation between thin current sheets, reconnection and turbulence in the magnetosheath

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We are investigating thin current sheets observed by the Cluster spacecraft in the magnetosheath close to a bowshock crossing. Other studies has provided evidence of ongoing reconnection associated with the current sheets using the same event. The characteristics of the current sheets are examined both using a time series approach and by applying turbulence methods. The typical width of a current sheet is found to be about an ion gyro radius and the typical distance between two current sheets corresponds to 1-2 ion gyro radii. Moreover, it seems that current sheets observed in the magnetosheath are a manifestation of turbulence, that is well described by an extended Kolmogorov model, including spatial intermittency.

Keywords: current sheets, reconnection, turbulence

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ASIII018 **Oral Presentation** **3326**

Observations of Reconnection Onset at the Magnetopause

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Alessandro Retin, Christopher J. Owen

Magnetic reconnection is an important process in plasmas which allows effective momentum and energy transfer across boundaries. Despite the fact that ongoing reconnection has been widely observed, the reconnection onset has been studied mainly in numerical simulations. We present Cluster spacecraft observations of several subsequent magnetopause crossings with density asymmetry and significant guide field Bm~B0 which show the evolution from a tangential to rotational magnetopause. At the initial stage the current sheet is narrow ~c/omegapi and has a Harris-like structure. Strong lower hybrid drift waves are observed at the current sheet edges/density gradients. Small scale magnetic islands with depleted plasma and increased guide (core) field are observed inside the current sheet, indicating the reconnection onset. During later crossings a much thicker magnetopause is observed, consistent with ongoing reconnection.

Keywords: magnetopause, reconnection, onset

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ASIII018 **Oral Presentation** **3327**

Energetic particle signatures in association with flux transfer events in the exterior cusp

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In this paper we use the Cluster-II/RAPID instruments to study bursts of energetic particles in the post-noon exterior cusp region and their relation to flux transfer events (FTE). On February 2, 2003, the Cluster satellites traversed across the exterior cusp on an outbound pass. The satellite configuration was such that C1, C2 and C4 were leading and quite close together, while C3 followed the others with a lag of about 30 min. The leading satellites observed the exterior cusp from 21:40 UT to 23:05 UT. Soon after leaving the cusp, the leading satellites observed numerous FTE-type signatures in the magnetic field, coinciding with significant bursts of energetic particles. The particle pitch-angle distribution shows that the energetic particles were released from the neighboring closed field lines of the high-latitude dayside magnetosphere in a reconnection process. At the same time C3 was still in the exterior cusp and also measured similar increases of energetic particle fluxes with and average delay of about 1 min compared to the leading satellites, suggesting that some of these particles could find their access to the exterior cusp. Calculations show that maximum energy gain per particle that can be attained by reconnection remains below 1 keV, thus far below the energy range of the RAPID instrument. Instead, the present findings support our earlier statistical results of the magnetospheric origin of energetic particles in the exterior cusp. Energetic particles can reach the cusp from the neighboring closed field lines either by direct diffusion or via the control of the dayside reconnection process. Thus, ultimately, the dominant source of energetic particles in the exterior cusp is the inner magnetosphere and the acceleration of these energetic particles mainly occurs in the near-Earth tail.

Keywords: magnetopause, reconnection, particles

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ASIII018 **Oral Presentation** **3328**

Transport of ionospheric oxygen across the turbulent magnetopause

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Cluster observations of the vicinity of the high latitude magnetopause indicate the presence of beams of singly charged oxygen ions, which are of ionospheric origin. In this paper we examine the role of magnetic turbulence combined with a dc electric field across the magnetopause in causing the cross field transport of protons and of singly charged oxygen ions, by means of a kinetic test particle simulation. We find that the observed values of magnetosheath turbulence and electric fields can produce a substantial escape of the oxygen ions relative to protons. By varying the magnetic turbulence level in the simulation, we find that the number of O$^+$ crossing the magnetopause growswith $delta B/B_0$, and that very few ions can cross themagnetopause for $delta B/B_0 = 0$. The ion temperature also growswith $delta B/B_0$, showing that magnetic turbulence is effectivein thermalizing the kinetic energy gain due to the cross-magnetopausepotential drop. We suggest that this mechanism can explain Cluster observations of energetic oxygen ions during a high-latitude magnetopause crossing.

Keywords: magnetopause, transport, turbulence

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ASIII018 **Oral Presentation** **3329**

Effect of IMF northward turning on the cusp particle precipitation observed by the Cluster spacecraft

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The polar cusp has been known to be a highly dynamic region since its first observations in the early 70s. Until recently, however, its motion in space could only be observed directly using statistics over hundreds or thousands of spacecraft crossings. With Cluster, with four spacecraft closely spaced, we can observe its quasi-instantaneous motion when the cusp is moving through the spacecraft near the exterior cusp or when the spacecraft are crossing successively the cusp at mid-altitude. In this presentation we will use mid-altitude cusp crossings. The IMF was turning from Southward to Northward during the crossings of the four spacecraft and we investigate the changes in the cusp position and in the ion and electron precipitation. The spacecraft were following each other within 2-8 min interval. The first two spacecraft observed the typical IMF-Southward ion dispersion, while the last one observed both an IMF-Southward dispersion, although with a reduced ion precipitation, and an IMF-Northward dispersion. After the IMF northward turning, the cusp was growing in size with the equatorward boundary moving equatorward and the poleward boundary moving poleward. These observations show the intermediate state of the cusp when the Northward-IMF injections have started in the lobes together with residual effect of the previous Southward-IMF on the dayside. These observations will be discussed in term of double lobe reconnection or simultaneous lobe and dayside reconnection.

Keywords: polar cusp, precipitation

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ASIII018 **Oral Presentation** **3330**

Interaction of solar wind discontinuities with the bow shock and influence of the magnetopause on this process

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The solar wind caries a variety of disturbances. The largest of them are usually connected with CMEs and resulting magnetic clouds. Interaction of these discontinuities with the Earth's magnetic field leads to initial compression of the whole magnetosphere that is followed by an expansion when the upstream conditions return to their usual values. Reported speeds of these compression/expansions range from several units to several hundreds of km/s. However, the interaction of discontinuities with the magnetopause is a complicated process leading to significant distortions of the magnetopause surface that can propagate downstream, and the determination of a speed of the magnetopause motion is rather difficult under these conditions. We compare profiles of the magnetic field and plasma parameters observed experimentally by several spacecraft in the solar wind and magnetosheath with the profiles of the same parameters resulting from the MHD magnetosheath numerical model. We can conclude that experimental magnetosheath data are well reproduced by modeled profiles despite the fact that the profiles exhibit complicated structures caused by the interaction of the IP shock with the Earth's bow shock and magnetopause.

Keywords: solar wind, magnetopause

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ASIII018 **Oral Presentation** **3331**

The magnetosheath as a source and sink of magnetospheric plasma

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The solar wind is a dominant source of the magnetospheric plasma. On the other hand, particles of the magnetospheric origin have been identified well upstream of the bow shock. Although a mutual coupling of these two regions - solar wind and magnetosphere - is mediated by the magnetosheath, a majority of studies tend to connect the magnetospheric phenomena with solar wind and IMF parameters and/or their changes and a role of the magnetosheath is usually neglected. This omission results from a general view of the magnetosheath being a region of a quiet flow where the IMF and plasma parameters are simply related to those in the solar wind. However, foreshock fluctuations are blown down to the magnetosheath bringing with them trapped energetic particles. These particles excite new types of waves and the disturbed plasma comes into a contact with the magnetopause. Pressure fluctuations distort its surface and variations of the plasma speed and magnetic field direction change the reconnection rate. Particles accelerated due to reconnection or magnetospheric particles on reconnected field lines again interact with an ambient plasma and enhance the level of fluctuations at the magnetopause. In this contribution, we bring a survey of some recent results of magnetosheath studies and discuss the importance of the magnetosheath processes for a plasma transport across the magnetopause. Since such studies require the simultaneous monitoring of the environment at both sides of the magnetopause, the contribution is based mainly on Interball and Cluster observations.

Keywords: magnetosheath studies, imf, plasma

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ASIII018 **Oral Presentation** **3332**

Reconnection between plasmas with different properties

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Using resistive MHD, we investigate the reconnection rate in current sheet configurations between plasmas of different properties. Specifically we investigate the effects of different magnetic field strengths and orientation and different density and identify scaling laws for the maximum reconnection rate.

Keywords: reconnection, plasmas, properties

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ASIII018 **Poster presentation** **3333**

Magnetosheath turbulence and boundary layer formation

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One of the main features of magnetosheath observations is the high level of magnetic field fluctuations. The amplitude of such fluctuations can be higher than the value of the magnetic field under the magnetopause at high latitudes. This means that the fluctuations of magnetic field in the magnetosheath are necessary to take into account in the magnetopause pressure balance. Local disruptions of such balance lead to the magnetosheath plasma penetration inside the magnetosphere and formation of local plasma jets. Dynamics of such jets inside the magnetosphere determines the properties of low latitude boundary layer (LLBL) and plasma mantle. Properties of magnetospheric boundary layers are discussed and compared with the results of Interball/Tail probe observations.

Keywords: magnetosheath, llbl, turbulence

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ASIII018 **Poster presentation** **3334**

Cluster-Double star and conjugate ground-based observations of dayside reconnection under different IMF conditions.

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Cluster and Double Star provide extensive, coverage of the Earth's dayside magnetosphere. A number of events provide close conjunctions with instrumentation at the Antarctic base, Zhongshan station. The cluster and Double star TC-1 spacecraft are conjugate with Zhongshan when one or more spacecraft lie in the cusp or magnetopause and the ground station lies under the cusp position. These conjunctions are typically also approximately conjugate with the ESR radar on Svalbard. On some occasions, Cluster provides upstream information, while TC-1 is conjugate with Zhongshan. In general, apart from the in situ space measurements, information is available in both hemispheres from a variety of ground instrumentation. Signatures of reconnection (FTEs and boundary layers), ULF wave signatures and other features of magnetospheric response, show corresponding, and often temporally related, ground signatures. Four key reconnection events are presented: 1. Conjugate ground magnetometer signatures can be shown to be temporally induced by pressure pulses in the solar wind. 2. Oppositely directed FTEs are associated with poleward moving forms seen in the ESR data and correlated signatures in the ground magnetometers and riometer beams. 3. Large scale FTE signatures are shown to have motions which are simultaneously reflected in the ground convection and in clear absorption signatures. 4. Simultaneous reconnection signatures are seen under conditions of low clock angle.

Keywords: reconnecion, ftes, conjugate

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ASIII018 **Poster presentation** **3335**

Cluster observations of interplanetary shock waves into the magnetosheath

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The interaction of two shock waves is a basic problem in plasma physiscs playing an important role in many processes occuring in space. In the past years, despite their importance, shock waves collisions have been subject of very few observational studies. Here we present some events, seen by the CLUSTER satellites, concerning interplanetary shock waves going through the magnetosheath after the impact with the Earth's bow-shock. These observations show the complex and non-linear nature of the phenomenon, actually the associated variations in plasma parameters and in the magnetic field are due, besides the transmitted interplanetary shocks, to other secondary (i.e. produced in the impact) discontinuities and waves. To this regard, we briefly compare our observations with the MHD theory predictions and some results coming from recent 3D simulations.

Keywords: magnetosheath

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ASIII018 **Poster presentation** **3336**

A Wind- Polar Study of Energetic Ion Bursts and Associated Polar Rain Electron Flux Enhancements During Magnetic Cloud Passage at Earth

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Per Even Sandholt, Arvind Sharma

We present correlated Wind-Polar observations of precipitation features in the northern, summer polar cap obtained during the passage of the sheath region of an interplanetary magnetic cloud. The sheath was characterized by an strong magnetic field whose direction spanned a wide range of orientations. Distinct field and flow discontinuities allow us to interpret a series of energetic (maximum E ~ 20 kV) ion bursts, flowing predominantly against the field direction and which are accompanied by enhanced polar rain electron fluxes. Proposed generating mechanisms such as (i) post-terminator FTEs, and (ii) overdraped lobe/dual reconnection are examined in the light of the observations.

Keywords: reconnection

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ASIII018 **Poster presentation** **3337**

Sudden Impulses at geostationary orbit and their relationships with magnetospheric current systems.

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Sudden Impulses (SI) of the magnetospheric field are caused by sudden increases in the dynamic pressure of the solar wind, generally associated with interplanetary shock waves, that compress the magnetosphere. They are currently interpreted in terms of an increase of the magnetopause and tail currents and possibly other magnetospheric current systems as well. We present an analysis of the SI manifestation at geostationary orbit during 2000-2004 focusing attention on the comparison between the magnetospheric response and the predictions of theoretical models in which the effects of the variations of the magnetopause current and those of additional magnetospheric current systems are evaluated.

Keywords: sudden impulses, magnetopause

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ASIII018 **Poster presentation** **3338**

Propagation of Electrostatic Solitary Waves in the Magnetosheath: Are they coming from the Magnetopause?

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Jolene S. Pickett, Ivar Christopher

We investigate the propagation of Electrostatic Solitary Waves (ESWs) in Earths magnetosheath through waveform observations made on the four Cluster satellites. ESWs are known to be potential structures such as electron and ion phase space holes and density enhancements and depletions. Cross correlation analysis of the waveform measurements made by the Wideband (WBD) plasma wave receiver onboard Cluster have provided convincing evidence that ESWs can propagate over distances as large as a few tens of km in the magnetosheath. By calculating the delay time between detection of an ESW on one spacecraft and to its detection on another, which is on the order of tens of milliseconds, we are able to obtain the speed and direction of propagation of the ESW. In at least one case we obtain a speed of 1,334 km/s away from Earth and the magnetopause. We also find that the shape of the structure associated with the ESW is very pancake-like or flat, with its size along the direction parallel to the magnetic field being much less than its size perpendicular to the magnetic field. Because it is very difficult to find convincing cases of ESW propagation using this method due to various instrumental and environmental factors, we are unable to say with certainty that all ESWs observed in the magnetosheath close to the magnetopause (within a few thousand km) have an origin at the magnetopause or are spawned out of reconnection. However, it is most certainly the case that many of the ESWs that are observed throughout the magnetosheath out to the bow shock do not originate at the magnetopause. Further investigations of ESW propagation in the magnetosheath are needed in order to better understand whether most or all of the ESWs observed in the magnetosheath close to the magnetopause boundary are coming from that region.

Keywords: magnetosheath, electrostatic solitary waves, propagation

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ASIII018 **Poster presentation** **3339**

Observations of the low frequency plasma waves in the polar cusp associated with strong fluxes of the energetic particles

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Interball 1 sometimes registered in the polar cusp emissions with extremely high intensity below the electron cyclotron frequency. These waves correlate with strong fluxes of high energetic electrons often observed within the polar cusp by Interball 1 and Magion 4 . Cluster measurements give new insight of these emissions. The observations of the waves at the frequencies close to electron cyclotron frequency done by Cluster satellites associated with strong fluxes of energetic electrons will be presented. Taking into account the plasma and magnetic field parameters in the polar cusp as well as geometry of the waves propagation, one has found that these emissions can be generated by so called fan instability, but also horse shoe instability can be discussed. Both instabilities play important role in the nonlinear wave particle interactions leading to the isotropisation of the fluxes of the particles and heating of the plasma. Some emissions at higher frequencies observed in polar cusp can be discussed as kilometric radiation in the cusp and also are associated with fluxes of energetic electrons.

Keywords: polar cusp, plasma waves, wave particle interactions

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ASIII018 **Poster presentation** **3340**

ULF waves in the cusp and in the magnetosheath regions: new results obtained with k-filtering analysis

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ULF wave activity is a recurrent, but not a permanent, feature of two key regions of the magnetosphere: the cusp and the magnetosheath. These two regions, respectively inside and outside the magnetosphere, are of a great interest to understand transfers through the magnetopause and to understand small scales processes such as magnetic reconnection. The analysis of the electromagnetic activity has been improved with the use of the Cluster mission multipoint measurements. The first case studies using the k-filtering analysis have underlined the presence of mirror modes close to the magnetopause under specific plasma parameters (Sahraoui et al., 2003, 2004) and of Alfvn waves during plasma injection events in the polar cusp (Grison et al., 2005). Here we propose to present results from new case studies corresponding to other physical situations (different locations in the magnetosheath, different plasma parameters, different cusp crossings) to confirm the universal features of the previous studies.

Keywords: ulf waves, k filtering

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ASIII018 **Poster presentation** **3341**

Multi-point perspectives of magnetospheric boundary layers and their relation to cold dense plasma sheet formation

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During conditions of northward interplanetary magnetic field (IMF), the near tail plasma sheet is known to become denser and cooler. The mechanisms, and their efficiency, which allow for the formation of this cold dense plasma sheet (CDPS) are of great interest, in particular whether plasma is transferred to the magnetosphere via poleward-of-cusp, lobe reconnection or via mechanisms at the flank magnetopause. In this study we present observations covering the period of the Double Star mission (~2004 onwards). The events focus on multiple spacecraft and ground based observations of the condition of the magnetospheric system under predominantly northward IMF driving conditions. This works is being carried out as part of an International Space Science Institute (ISSI) working group on Comparative Cluster- Double Star measurements of the Magnetotail.

Keywords: plasmasheet, cluster, doublestar

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ASIII018 **Poster presentation** **3342**

Response of the magnetosphere to tangential stresses applied at its boundary

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Observations in the interplanetary medium (ACE, WIND), at theduskside magnetopause (Cluster), inside themagnetosphere (FAST, GOES, Geotail) and at ground magnetometers spanning a wide range in local time and latitude are complemented by theory to illustrate various aspects ofmagnetosphere-ionosphere (M-I) coupling during an event characterized by an impulsive change in interplanetary field and flow parameters.We show the discontinuity to be simultaneously a tangential discontinuity (TD) and a vortex sheet (VS) with the field and flow executing a large rotationfrom west to east. The field turns subsequently northward.Two types of waves are excited at the magnetopause duringand after the TD/VS interaction with it. The attendant magnetopausemotions produced large effects on the geomagnetic field, setting up standing Alfvn waveson resonating shells. Compressible calculations confirm the presence ofMP surface waves of a Kelvin-Helmholtz origin, in addition to the initialundulatory motions of large amplitude. A two-stage response of the magnetosphere is documented. The continuous ground coveragefrom magnetometer arrays and the in situ observations permits us to detailthe global response of the magnetosphere to the applied tangential stresses.

Keywords: magnetopause, waves, kelvin helmholtz

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ASIII018 **Poster presentation** **3343**

Occurrence of reconnection jets at the dayside magnetopause: Double Star observations.

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Many satellite and ground based observations confirm that magnetic reconnection is a fundamental process for the transfer of mass and energy across the magnetopause. However, many questions are still open regarding the way reconnection occurs. We present a statistical study on reconnection events performed using the Double Star TC1 plasma and magnetic field data for the years 2004 and 2005. The TC1 satellite has an equatorial orbit, with an apogee of 12.4 Earth radii, that allows to explore the low latitude dayside magnetopause. In the interval 06 LT to 18 LT, we identified plasma flows, at the magnetopause or in the boundary layer, with a different velocity with respect to the adjacent magnetosheath. The Walen relation has been used to test which of these flows could be generated by magnetic reconnection. We analysed the occurrence of the reconnection jets in relation to the magnetosheath parameters. Moreover, a detailed study of the agreement of the these flows with the Walen relation is performed.

Keywords: reconnection, magnetopause

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ASIII018 **Poster presentation** **3344**

Plasma sheet during dual lobe reconnection: a case study

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Maria Federica Marcucci

Since the early sixties, it has been proposed that, when the interplanetary magnetic field (IMF) points northward, it could reconnect with the lobe field lines at high latitudes, tailward of the magnetospheric cusps. If lobe reconnection occurs simultaneously at both hemispheres, magnetosheath plasma can be captured in the magnetosphere. This is one of the mechanism by which a cold dense plasma sheet (CDPS) is formed during northward IMF. Other mechanisms acting at the flank magnetopause, such as non-linear KH instabilities and diffusion, can be responsible for the formations of the CDPS. In recent years, satellite and ground based observations have provided evidence of the occurrence of dual lobe reconnection. Here, we study the evolution of the plasma sheet during a period when dual reconnection is evidenced by means of ionospheric high latitudes observations and in situ measurements at the magnetopause. With this aim, we apply the Orsini et al. (2004) method to the LANL data, in order to reconstruct the global equatorial proton distribution during this period.

Keywords: dual reconnection, plasma sheet, equatorial proto distribution

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ASIII018 **Poster presentation** **3345**

Conditions for a Kelvin-Helmholtz stable gap at the supersonic near equatorial magnetopause flanks for northward IMF

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There are physical regimes of the solar wind under northward IMF conditions such that the near, but already supersonic, flank of the magnetopause (MP) is stable to Kelvin-Helmholtz (KH) perturbation modes. We analyze the stability with an equilibrium model of the low latitude boundary layer (LLBL), based on hyperbolic tangent profiles for the main scalar and vector fields, and ideal, compressible, MHD equations. When the sonic Mach number becomes larger than ~1.2-1.4 while the Alfven Mach number is somewhat smaller (MA < or ~ 1.2), negligible growth rates of the perturbations in the LLBL are possible. Local stability is obtained when, at the same time, there is magnetic shear between the geomagnetic and the interplanetary magnetic field. This outcome is due to the stabilizing effect of compressibility on the supersonic side of the boundary layer, combined with the effect of magnetic tensions in the current sheath part of the LLBL. Solar winds favourable to stability are cold, not too dense, plasmas, with strong magnetic fields, so that MA increases, while M decreases, compared to average values. We report also theoretical results where the input parameters for the boundary layer model are suggested by observations of spacecrafts crossings at the equatorial flanks, complemented with judicious extrapolations of the conditions upstream, and downstream, of the crossing locale. We conclude that a gap in the amplification regions for KH disturbances of the near equatorial flank should be expected when the above mentioned features are realized. When large scale KH vortices are observed in the flank LLBL the question arises as how far upstream they have been generated. Under the conditions discussed, it may be the case that the source of the LLBL turbulence is not a locale only a number of amplification lengths upstream, but a far-away site on the dayside MP.

Keywords: magnetopause, solar wind

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ASIII019 **3346 - 3384**

Symposium
Progressing to closure in magnetotail plasma sheet and substorm processes

Convener : Dr. Vassilis Angelopoulos
Co-Convener : Prof. Wolfgang Baumjohann

Much progress has been made recently on the dynamics of the thin current sheets developing in the central region of the geomagnetic tail. The magnetotail current sheet has proven to be the seat of more complex structure and dynamics than expected involving multiple current sheets, coupling of micro- and meso-scale dynamics and turbulent structures and flows. Notably, multi-satellite missions provide new observational capabilities enabling critical tests of competing mechanisms of energy release and tail reconfiguration. The symposium provides a forum for discussion of the relevant scales for current sheet dynamics, evaluating evidence for and against proposed instability processes, and comparison with theory, simulation and modeling to identify the key processes relevant to magnetotail and substorm processes and their manifestation in global scale substorm development. Contributions are welcome that address the dynamics of current sheets and their relation to substorms. Priority will be given to near Earth and mid-tail regions.

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ASIII019 **Oral Presentation** **3346**

Current sheet flapping and magnetotail activity

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Considerable local vertical motions (called 'flapping') are well-known among dramatic dynamic perturbations of the magnetotail current sheet, although detailed information about their properties was only recently obtained. New possibilities of Cluster mission advance our understanding of both the tail current sheet (CS) dynamics (flapping mode), as well as about its structure, whereas extensive survey provided by Geotail mission allowed to probe their distributions and other statistical characteristics. With greatly advanced capabilities of measuring gradients and propagation Cluster made it clear that previous picture of smooth and almost planar sheets is rarely applied. Real sheet dynamics often includes large-amplitude meso-scale sheet corrugations in which the sheet (1) is strongly deformed and tilted locally, (2) the perturbation has a kink-like structure (of a few Re scale, with CS normal rotating in YZ plane), they are (3) seen most frequently in the central tail sector and (4) propagate systematically from central sector toward the tail flanks (confirming their generation in the magnetosphere). They are frequently associated with substorm expansions, however considerable part of them (more than a quarter) is observed under quiet auroral conditions. Their spatial distribution is similar to that of the bursty bulk flows, although there is no simple local relationship between these two phenomena. Very thin strongly tilted dynamic sheets are also observed in/near the reconnection diffusion region. The formation/propagation mechanism(s) are under the study although many facts point out to their close relationship to substorm activations and BBF generation. We also discuss the properties of the flapping structures as obtained from 3d-MHD simulations. On the other hand, flapping current sheets demonstrate a wealth of complicated sheet structures (thin embedded as well as bifurcated sheets etc) of different scale (ranging from thin sheets comparable to ion ineretial length to thick sheets) in which ions are not the main current carriers. The major finding so far is that, unlike the pre-Cluster view of the tail current sheet, we face the variety of essentially non-Harris and variable current sheet plasma distributions, which require a new step in the theoretical analysis.

Keywords: magnetotail, structure, dynamics

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ASIII019 **Oral Presentation** **3347**

The current disruption model for substorms

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The development of the current disruption model as an alternative to the near-Earth neutral line model for substorm phenomena began back in the mid 1970s. Research efforts on the model from the past three decades encompass data analysis, analytical theoretical treatment, and numerical simulations. In this presentation, we summarize the present status of the model from these three different approaches. We then discuss the means by which the potential physical processes for current disruption may be tested and on future improvements on the model.

Keywords: substorm, plasma instabilities, current sheet

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ASIII019 **Oral Presentation** **3348**

Cluster observations of broadband electromagnetic waves in and around a reconnection region in the terrestrial magnetotail current sheet

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We present an analysis of the electric and magnetic wave spectra on kinetic scales during several crossings of a reconnecting current sheet. The spectra were measured from 1 Hz or less up to 4096 Hz by the EFW, FGM and STAFF instruments onboard the Cluster spacecraft between 3 and 4 UT on 11 October 2001. During the event plasma flows of order of the local Alfven speed reversed from tailward to earthward, suggesting that a reconnection site moved over the spacecraft. We ordered the observed electric and magnetic field wave spectrum by the position within the current sheet using the magnitude of the magnetic field. We found that the electric and magnetic wave power decreased considerably at all frequencies towards the center of the current sheet. The electric energy density decreases 5 orders of magnitude from the edge of the current sheet to the center and the magnetic energy density peaks within the current sheet and is decreased by 2.5 orders of magnitude at the center. Within the current sheet, the electric and magnetic wave spectra were dominantly broadband electromagnetic noise (i.e., power law spectra with exponents ~-1.4 and ~ -2.4, respectively) throughout the frequency range ~ 0.1 - 1000 Hz, spanning from MHD to almost the electron plasma frequency. We argue that the wave activity is likely to be whistler wave turbulence and discuss the implications of these results for reconnection from wave-particle interactions.

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ASIII019 **Oral Presentation** **3349**

Substorm current sheet dynamics: a case study

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We present coordinated space and ground-based observations of magnetotail current sheet dynamics during a substorm between 2330 and 2400 UT on August 28, 2005. Cluster was located in the central plasma sheet at [-17.2, -4.49, 0.03] RE (GSM) with the foot points within the IMAGE ground-based network. The spacecraft quartet configuration was "multi-scale" with the distance between C3 and C4 10 times smaller than the other distances. Using the C3-C4 pair, separated by ~900 km, we probe the current sheet structure, estimating current density and current sheet thickness. It was found that the current sheet thickness decreases down to <1000 km with the current density increasing up to 30 nA/m^2 near substorm onset. The thinning of the current sheet was accompanied by tailward plasma flow at a velocity of -800 km/s and subsequent reversal to Earthward flow at Vx~800 km/s coinciding with a Bz turning from -5 to +10 nT. Detailed analysis of ion and electron distributions near the flow reversal shows microscopic signatures of reconnection. An enhancement of the ionspheric equivalent current, calculated from the IMAGE ground-based magnetometer network, was observed during 2330 - 2345 UT.

Keywords: magnetotail, reconnection, substorm

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ASIII019 **Oral Presentation** **3350**

Quasi-periodic dipolarisations in the mid-magnetotail observed by Cluster and Double star

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During the Autumn of 2004 the four Cluster and two Double Star spacecraft favourably sampled the Earth's magnetotail on a number of passes during which the plasma sheet underwent a series of substorm induced reconfigurations. These spacecraft were situated between ~10-16 Re downtail, at various distances from the current sheet. We focus on a two day period during which all six spacecraft were in a good location to observe properties of the near-tail plasma sheet. The current sheet is shown to thicken at Cluster just after a significant diplolarisation is observed at the Double Star TC-1 spacecraft. At this time Cluster lies above and ~3-4 Re down tail from TC-1. An earlier period showes a clear simultaneous encounter of the dipolarisation front by all spacecraft, while the Cluster array lay above and TC-1 lay below the current sheet at about the same radial distance. During these times the Double Star TC-2 spacecraft samped near Earth field lines which connected to either TC-1 or the position of Cluster at different intervals.

Keywords: magnetotail, dipolarization

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ASIII019 **Oral Presentation** **3351**

Current sheet flapping with tilted Hall fields and changing propagation speed during tail reconnection

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On 11 October 2001 Cluster recorded the magnetotail current sheet for an extended period which included the entire duration of a reconnection event. Current sheet oscillations were observed both before reconnection and during it. The speed of the flapping motions is found to increase when the current sheet undergoes the transition from quiet to active state, as suggested by an earlier statistical result and now confirmed within one single event. Within the diffusion region both the tailward and earthward parts of the quadrupolar magnetic Hall structure are recorded as the main x-line passes Cluster. We report the first observations of the Hall fields conforming to the kinks in the current sheet. This results in relatively strong fluctuations in Bz, which are shown to be the Hall signature tilted in the yz plane with the current sheet.

Keywords: magnetotail, reconnection, current sheet

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ASIII019 **Oral Presentation** **3352**

Energetic Electron Acceleration in the Downstream Reconnection Outflow Region

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Energetic electrons in an earthward reconnection outflow region have been observed by Cluster/RAPID. We found a good correlation between the energetic electron enhancement and a normal magnetic field (Bz) enhancement within a 0.25-second time resolution. The large normal magnetic field is thought to be associated with magnetic reconnection, because the negative/positive Bz reversal observed during the fast proton tailward/earthward flow reversal is a good indicator for magnetic reconnection. Using the four spacecraft Cluster, we can clearly see that this large positive Bz structure propagates in the earthward direction. Furthermore, we find that the energy spectrum of the energetic electrons becomes harder toward the downstream region. A negative Bz enhancement is also observed. The intensity of energetic electrons enhancement associated with the negative Bz enhancement is weaker than that associated with the positive one. To discuss the temporal and spatial profile of energetic electron acceleration in the magnetic reconnection region, we determined the spacecraft position in the temporally evolving magnetic structures of reconnection. Our observation clearly indi cates second step acceleration, in addition to X-line acceleration, of energetic electrons in the downstream reconnection outflow region.

Keywords: reconnection, energetic, electron

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ASIII019 **Oral Presentation** **3353**

Plasma sheet ion pressure profiles during substorm

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Jesper Gjerloev

Over 200 substorm events were carefully selected from observations made by Polar UVI, VIS, and an ensemble of ground instruments. From these events, more than 140 of them have simultaneous DMSP observations. Four substorm phases were defined, namely, growth, expansion, early recovery, and late recovery. Plasma sheet 2-D ion pressure, density, and temperature profiles inferred from DMSP satellite observations were constructed for each of these four substorm phases. The growth phase profiles show that the ion pressure is higher in the inner edge of the plasma sheet. The premidnight pressure enhancement can be attributed to the temperature enhancement while the postmidnight pressure enhancement can be attributed to the density enhancement. The temperature enhancement at premidnight has been previously reported and attributed to the curvature and gradient drift of the ions. The postmidnight density enhancement may result from the enhanced convection. The profiles show that the ion pressure near the midnight meridian in the midtail region increases right after the substorm onset, during the expansion phase. The pressure subsequently declines during the early recovery phase and declines further during the late recovery phase, but the late recovery pressure is still higher than that of the growth phase. This near midnight pressure enhancement during the expansion and recovery phases can be attributed to both temperature and density enhancements. The 2-D pressure, temperature, and density profiles provide observational constraints to the competing substorm theories.

Keywords: substorm, pressure, density

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ASIII019 **Oral Presentation** **3354**

Instabilities in thin tail current sheets

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Olivier Le Contel, Dominique Fontaine, Patrick Robert, Philippe Louarn, Andrew Fazakerley

On September 12th, 2001 the four Cluster spacecraft remained for almost one hour in a thin tail current sheet (CS). At the end of the growth phase, the CS became so thin that only one spacecraft could remain inside it. On this spacecraft evidence was given for bi-directional electron distributions, together with a large By component confined very close to the equator (not a guide field). In spite of the small thickness (~1000-1500km) of the CS this configuration is relatively stable; it lasts almost 10 mn. It is argued that the magnetic shear associated with By, is stabilizing the magnetic configuration. A few minutes later the CS thickness remains similar, but the By component weakens. Large amplitude oscillations are then observed, together with quasi nulls in the modulus of B. We therefore expect to observe large ion flows. In fact the ion flows associated with these quasi-nulls are rather modest (~200-300km/sec), which is due to the fact that the Ey component tends to cancel at the same time as B. The E and B modulations are not consistent with a tearing mode; they are consistent with an eastward moving kink mode. No evidence is found for a Hall structure. Only when the CS thickens do we observe signatures of fast flows (~800km/sec) bursts, associated with filamentary structures that move eastward, and intense high frequency waves. These observations suggest that the non linear evolution of the kink mode leads to a filamentation of the current and to the reconfiguration of B and the fast ion bursts.

Keywords: substorms, instabilities

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ASIII019 **Oral Presentation** **3355**

Multi-point observations of thin current sheets

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Thin current sheets are known to play a central role in magnetotail physics. Using the four-point measurements by Cluster separated on a spatial scale of less than an ion inertia length, we examined detailed profiles of ion-scale current sheets during reconnection events in the Earth's magnetotail. In particular, we highlight reconnection events with the signature of a large guide field. Strong guide field cases in magnetotail reconnection have been rarely reported so far, since on average a guide field is not expected to play a central role in the magnetotail. Yet, some local (temporal) fluctuations and tilt of the current sheet may create an effective guide field and associated signatures are detected in the electron distribution and the structure of the current sheet. These 3-D temporal/local events with less-than-minute scale were observed during a longer lasting thin current sheet interval showing X-line signatures (reversal from tailward flows with negative Bz to Earthward flows with positive Bz) on average.

Keywords: current sheet, cluster, reconnection

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ASIII019 **Oral Presentation** **3356**

Thinning and stretching of the magnetotail's plasma sheet

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With Cluster observations in the magnetotail we study dynamics of plasma sheet thinning and stretching during 39 intervals. Cross-tail current density generally scales J0 ~ Tp/Bz, but with frequent transient variations. Typical pre-onset values are Bz ~ 1-2 nT , J0 ~ 4-8 nA/m2, thickness >3000 km. Current density increase on average is not accompanied with a corresponding number density increase. About 30% of events are characterized by the large (>5 nT) guide field component, implying adiabatic particle dynamics even with small Bz. Most of local onsets, associated with ends of our thin sheet intervals, were with tailward flows. In some cases embedded current sheet structure was detected and, therefore, estimation of thickness requires a caution.

Keywords: magnetotail, substorm

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ASIII019 **Oral Presentation** **3357**

Response of nightside magnetosphere to IMF variation: multipoint observations

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The response of nightside magnetosphere to IMF variation was investigated with magnetic, auroral, and plasma flow observations in space and on the ground during 0800-1400 UT on 7 December 1997. The IMF structure propagating to the Earth had four recurrent variation cycles of north to south and north again during the time of interest. Likewise, there were four distinct cycles of growth and subsequent decay in the AL index except the last one consisting of three subcycles. For each cycle, two Pi2 pulsation bursts consecutively occurred at low latitudes but three in the fourth cycle. Concurrently at synchronous orbit, GOES 9 sensed magnetic enhancements like the one affected by the substorm current wedge for the first three cycles. At the inner region of the plasma sheet, Interball detected the similar enhanced disturbances accompanied by smaller ones at each Pi2 onset. Meanwhile in the central plasma sheet, Geotail moving outbound observed earthward fast flows bearing the northward magnetic field following the second Pi2 onset in each cycle. In the south lobes of the mid-tail, IMP 8 observed four distinct magnetic depressions like the one caused by tail stretching after plasmoid ejection. The comparison of magnetic, auroral and plasma data with IMF observations shows that a sequence of four double-onset substorms appears in four distinct cycles of southward IMF followed by a northward turning. These observations can be explained with the prevailing model of externally triggered substorm. Consequently, this event manifests existence and interplay of two impulsive sources in the near Earth region and the distant Earth region in the plasma sheet during multiple-onset substorms.

Keywords: substorm, imf variation, pi2 pulsation

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ASIII019 **Oral Presentation** **3358**

Low-frequency electromagnetic modes driven by oxygen ions in the plasma sheet region

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Low-frequency electromagnetic modes are studied in three component plasma consisting of electrons, protons and oxygen ions in the plasma sheet region. The model considers velocity shear for each species. A linear dispersion for low-frequency electromagnetic waves is derived and solved numerically for such a system. The effects of oxygen ion beam speed, velocity shear and oxygen ion temperature on the growth of these modes are investigated. The results are applied to the plasma sheet region.

Keywords: low frequency, electromagnetic, waves

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ASIII019 **Oral Presentation** **3359**

Structure and stability of thin current sheets in collisionless plasma

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Current sheets (and especially thin current sheets - TCSs) could be considered as one of the key elements in collisionless plasma of the Earths magnetosphere due to their property to accumulate magnetic energy. An analytical 1D self-consistent TCS model is presented where multicomponent plasma consists of electrons and ions of both solar wind and ionospheric origin and magnetic field reversal produced by TCS is quasineutral because it contains small, but very important transverse component of magnetic field. Electron population which is taken into account in Boltzman approximation supports very sharp, but narrow peak of the electron current density in the center of the current sheet, which could account for 20-30% of the total cros-tail current. The contribution of non-adiabatic heavy O+ ions to the self-consistent solution of the GradShafranov-like system of equations produces significant (3-4 times) broadening of the current profile, although the net contribution of oxygen ions to total cross-tail current usually does not exceed 30%. It is shown that anisotropic current sheets represent larger free energy reservoir than classical Harris-like sheets, which motivated us to revisit the long-standing problem of their tearing mode stability. Contrary to previous investigations of Harris-like current sheets with Bn not equal to zero, which were found to be stable due to electron compressibility effect, we have revealed that few localized zones of instability might exist in parameter space of our system. It is shown that the main island of instability is concentrated near Bn~(0.1-0.2)Bo and its width depends on such TCS parameters as the temperature ratio Ti/Te, average pitch-angles of electrons and initial anisotropy of ion source eps=vT/vD. Therefore, our analysis could describe both the multilayered structure of TCSs and their dynamic behavior, which might have numerous implications for substorm physics.

Keywords: magnetotail, stability, structure

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ASIII019 **Oral Presentation** **3360**

Connection between tail transport and the Harang reversal, their changes, and substorm dynamics

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The plasma sheet continuity equation will be used to show how basic plasma sheet sources and losses resulting from plasma sheet transport offer an explanation for the substorm growth phase and for substorm onset. We will specifically show how this transport could led to substorms triggered by IMF and by solar wind dynamic pressure P changes, to null events that we suggest result from an important interplay of simultaneous IMF and P changes that can prevent substorm triggering, to steady magnetospheric convection events via a steady state balance between plasma sheet sources and losses, and to pseudo-substorms via a nullifying IMF or P that increases the plasma sheet source after onset thus terminating substorm expansion before full development. We will also illustrate how observations from the THEMIS mission will provide critical information for the evaluation and further development of the above suggestions.

Keywords: substorms, plasma sheet, convection

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ASIII019 **Oral Presentation** **3361**

Evolution of electron distributions and the magnetic structure in the thin current sheet during magnetic reconnections

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Magnetic reconnection is one of the most important processes in substorms and is closely related to the energy release and the flux transport in the magnetotail. Various kinds of plasma distributions around the X line originate from such dynamicprocesses, and it is important to reveal the causality of such signatures and their contribution to global-scale phenomena in understanding evolution of the substorm and the role of magnetic reconnection in substorms.Using Cluster high time-resolution multi-satellite data, we investigate the evolution of electron acceleration and thermalization processes around near-Earth neutral lines. Spatial and temporal characteristics of the isotropic flat-top electron distribution in phase space are taken into account, which are identified as related to the highly accelerated electron beams and most frequently located near the outer boundary of the ion diffusion region.Comparing the flat-top distribution and local magnetic / electric field structures mostly inside the thin current sheet, supra-thermal acceleration of electrons are found not to be directly related to the formation of such electron distributions, indicating the existence of further acceleration mechanism in the reconnection regime. We also discuss the effect of the local and temporal magnetic field structure in the course of reconnection for the formation of the beams and evolution of the acceleration and thermalization processes.

Keywords: substorm, reconnection, electron

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ASIII019 **Oral Presentation** **3362**

Current sheet dynamics in relation to Pi2 pulsations

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Recently, lobe Pi2 pulsations were reported in the mid-tail region that occurred at substorm onset and were driven by pulsed reconnection. The lobe Pi2s showed the magnetic field signatures of traveling compression regions (TCRs). Using multipoint observations (ACE, Cluster, Geotail, Polar, LANL, ground magnetometer stations), we will compare the substorm-related lobe Pi2s with lobe Pi2s that occurred during geomagnetically quiet times by following the energy flow from 226 Re upstream in the solar wind, to the mid-tail region, to the near-Earth region, to geosynchronous orbit, and to the ground. Whereas the substorm-related lobe Pi2s are observed on the ground, the non-substorm lobe Pi2 are not. We will discuss the role of current sheet configuration in the propagation and shielding of lobe Pi2 signals to the ground.

Keywords: substorm, pi2, current sheet

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ASIII019 **Oral Presentation** **3363**

Overview of the THEMIS mission and datasets

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The THEMIS mission launched successfullyon Feb 17, 2007. It employs five probes (micro-satellites) equipped with three-dimensional particle and fields measurements at 3 second spin period time resolution in a unique constellation formation that will time the process of reconnection and current disruption phenomena to address the issues of substorm causality, to link key substorm processes, and to determine relevant spatial gradients over distances on the order of an Earth radius. THEMIS was launched into the pre-midnight sector with an apogee of 15.9Re. As the instruments are being turned on they are providing radial profiles of the pre-midnight sector at 6-9 Re distances. The probes will undergo a very thorough instrument calibration in the summer of 2007, and at the same time they will provide a unique look at dayside and radiation belt processes over scale sizes ranging from hundreds of km to an Earth radius during their initial coast phase. The THEMIS ground observatories are specifically designed to determine the onset times and meridians of substorms using white light imaging at 3s resolution and ground magnetometers at 0.5s resolution. The prime tail season is the winter seasons(February +/- 2mo)of 2008 and 2009. The THEMIS constellation will thenbe synchronized to obtain 15 hours of useful alignments every 4 days , when in the magnetotail and on the dayside (August +/- 2mo). These time-based conjunctions mark the collection of fast survey data, and enable on-board selection of burst data using event triggers. The memory management allows maximum data rates from particle instruments and high frequency waveforms to be collected using reasonable on-board data storage and downlink capabilities. The data will be routinely available on the web, along with IDL-based software for quick data analysis. Quick turnaround for data validation is expected, but researchers are advised to work directly with the pertinent team members to avoid data pitfalls. Synergies with ground based, FAST, ISTP (Geotail, POLAR), Cluster and Double Star, as well as simulation communities will be discussed.

Keywords: plasma sheet, magnetotail, substorms

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ASIII019 **Oral Presentation** **3364**

Electron dispersed structures on the open-closed boundary as a tool for remote study of the reconnection process

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Reconnection processes in the Earth's magnetotail are responsible for the reconfiguration of magnetic field lines during substorms. In situ plasma data from magnetospheric spacecraft can be used to study this process, although because the reconnection diffusion region is relatively small, the chances of sampling it directly are low. Here we present an analysis of electron phase space distributions in the separatrix region near the tail plasma sheet boundary layer. Energy-dispersed electron signatures suggest an ongoing active reconnection process, with quantitative analysis giving information about the X-line location. Comparison of phase-space distributions of polar rain electrons and accelerated electrons on the separatrix allows reconstruction of the electron acceleration characteristics in the diffusion region through application of the Liouville theorem. These results show that study of electron dispersed structures on the open closed boundary is an important tool for studying magnetotail reconnection.

Keywords: reconnection, electron acceleration, energy disperse structures

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ASIII019 **Oral Presentation** **3365**

ULF waves as a diagnostic of the nightside magnetosphere

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With the successful launch of the THEMIS spacecraft, the expansion of the CARISMA magnetometer array, and the deployment of the THEMIS GBOs, there exists an exceptional opportunity to study fundamental science in the nightside magnetosphere around substorm onset. We use ULF pulsations to diagnose magnetospheric characteristics on a range of timescales, including the Pi2 (40-200 second period) and the Pi1B (1-40s period) waveforms. Using these pulsations, we can answer several remaining questions concerning the nightside magnetosphere, such as whether high-latitude Pi2s are most likely a resonant response of the nightside geomagnetic field, or a variation in the temporal dynamics of the magnetotail driver. We present specific examples whereby we can recreate discrete points along the Alfven continuum for the first time following the substorm expansion phase onset. We find that, at least in these event studies, the Pi2 structure is most likely determined from inherent frequencies of the nightside magnetosphere, rather than any variation in the temporal dynamics of the magnetotail driver. A Pi2 detection algorithm [Nose et al., 1998] will be applied to the realtime CARISMA data to generate a comprehensive database of substorm onset events. Subsequent analysis of the associated Pi1B pulsations across the combined array should allow substorm onset timing to within an accuracy of 10 seconds. Finally, we outline the use of the substorm location modeling algorithm [Cramoysan et al., 1995] to mid-latitude magnetometer data to produce initial estimates of the locations of the upward and downward field aligned currents and the Westward electrojet. The timing and location results will be published on the Canadian Space Science Data Portal (http://www.cssdp.ca)

Keywords: substorm, ulf, timing

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ASIII019 **Oral Presentation** **3366**

Electron populations in thin current sheets during growth phases and substorms

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CETP CNRS IAGA

Roux Alain, Le Contel Olivier, Robert Patrick, Owen Chris

During the growth phase and at the triggering of substorms, the current sheet in the equatorial magnetotail can become very thin. At about 20 terrestrial radii, Cluster crossed such thin current sheets with thicknesses estimated to be of the order of one to a few ion gyroradii. The plasma sheet activity regarding the magnetic field fluctuations and the wave activity seems to depend on the scale of this thickness. In the mean time, Cluster observes different particle behaviours in addition to the expected keV plasmasheet ions and electrons. In some cases, fast ion flow bursts are detected as already reported by other observations at substorms onset. In other cases, during the growth phase, Cluster may observe field-aligned low-energy electrons over limited spatial extensions. All these particles contribute to currents. The total current, estimated from the magnetic field fluctuations, put forward different current carriers. The objective of this study consists to compute the currents carried by the different populations, to identify the dominant current carrier and try to infer their different scales by comparison to the current sheet thickness.

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ASIII019 **Oral Presentation** **3367**

Magnetic island coalescence in a thin current sheet

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Magnetic island coalescence process in a thin current sheet has been studied by using two- and three-dimensional full particle simulations. Previous simulation results show that the initial scale length of the magnetic islands due to the non-linear evolution of the tearing instability is about twelve times of the current sheet thickness. The size corresponds to about 0.5 Re for the magnetotail cases. However, the observed sizes of plasmoids are longer than ~4 Re. (Ieda et al. 1998) Thus, we expect that magnetic island coalescence really occurs in the magnetotail. Recently, Cluster-II observed a magnetic O-point in a thin current sheet crossing event. (Retino et al. 2006) In this paper, we try to explain the observed feature, such as the density dip and the strong core guide field, by magnetic island coalescence process. To compare the observed features to numerical simulation results, a systematic survey has been done varying the initial number of magnetic islands, the initial current sheet thickness and the strength of the guide field. As a result, we found that only limited number of initial magnetic islands and current sheet thickness can explain the observed characteristics quantitatively. We will discuss a possible scenario of magnetic island evolution process in a magnetotail thin current sheet based on our comparing study. Another interesting feature relating to electron acceleration associated with magnetic island coalescence will also be discussed.

Keywords: reconnection, coalescence, magnetic island

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ASIII019 **Oral Presentation** **3368**

Solitary Electromagnetic Pulses Detected with Super-Alfvnic flows

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A long-standing unsolved problem in space physics concerns the understanding of mechanisms that produce plasmas that flow at hundreds of km s-1 in the geomagnetic tail. Observations have shown that most flow speeds are sub-Alfvnic and can be explained by reconnection theories and simulation models. However, observations have also shown that on occasions, plasmas can flow faster than the Alfven speed. The significance of super-Alfvnic flows and the possible nonlinear effects that might accompany them were not discussed. Here we report first observations of solitary electromagnetic pulses (solitary waves) detected in the Earths geomagnetic tail during intervals of super-Alfvnic flows and discuss their properties relevant for understanding the dynamics of substorms.

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ASIII019 **Oral Presentation** **3369**

The role of the magnetic turbulence on the dynamics of non-adiabatic ions in the cross-tail current sheet.

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The influence on non adiabatic ion (including O+ ions) motion of magnetic turbulence, observed in the near-Earth magnetotail, is investigated by numerical simulation. The magnetotail current sheet is modelled as a magnetic field reversal with a normal magnetic field component Bn, plus a three dimensional spectrum of magnetic fluctuations, which represents the observed magnetic turbulence. A cross tail electric field Ey is included.A test particle simulation is performed assuming an anisotropic plasma source at the magnetospheric lobes, and using different values of the fluctuation level, injection energies and electric field.In the relevant range of parameters, the fluctuation level and the electric field have opposite effects on the current structure and on the ion heating. A set of parameters very close to observations is discussed.

Keywords: magnetotail, turbulence, non adiabatic ions

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ASIII019 **Oral Presentation** **3370**

Generation, Propagation and Interactions of Alfvnic Disturbances in the Magnetotail: Simulations

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Yan Song, Thomas W. Jones

Understanding the relative timing of plasma processes between different regions of the magnetotail requires an understanding of wave propagation processes in the tail. These wave disturbances are frequently localized in space, and contain magnetic perturbations as strong as the background magnetic fields. Such disturbances have been modeled using a nonlinear MHD code that can treat varying locations within the near and mid-tail regions. We suggest that such disturbances can be generated by localized, time-dependent reconnection processes and lead to strong interactions that can result in nonlinear mode conversion, coupling compressional and shear mode waves. Implications of these interactions for the propagation of signals in the plasma sheet with application to upcoming THEMIS results will be discussed.

Keywords: alfven waves, mhd simulations, magnetotail

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ASIII019 **Oral Presentation** **3371**

Investigation of the Nightside Magnetosphere through Travel-time Magnetoseismology

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This study analyzes the arrival time of Pi 2 pulsations observed at multiple satellites and ground stations to infer the source location and timing of substorm onsets and bursty bulk flows. The methodology is analogous to terrestrial seismology in which the arrival time of seismic waves is used to estimate the location of earthquake hypocenters and the internal structure within the Earth. The onset time and location of substorms can be inferred from the travel-time magnetoseismic analysis, and, through the comparison with images of auroral brightening, the research can clarify the time history of substorm phenomena and help identify the responsible physical model. The analysis on BBF-generated Pi 2 can also pinpoint the source locations of these fast flows in the plasma sheet. Using the observations of Pi 2 arrival time and the modeled propagation time, we find several cases where the most likely source location of Pi 2 is at 12-15 RE downtail. We will also discuss how this new methodology can use the Heliophysics Great Observatory in the magnetotail, including the five THEMIS satellites launched in February 2007, as seismometers in the outer space to infer the state of the nightside magnetosphere.

Keywords: magnetoseismology, substorms, pi2 waves

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ASIII019 **Oral Presentation** **3372**

Ion beam variability in the Plasma Sheet Boundary Layer

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Jean-Michel Bosqued, Mostafa El-Alaoui, Vahe Peroomian, Raymond Walker

We have investigated the occurrence and variability of ion beams in the plasma sheet boundary layer (PSBL) by using Large Scale Kinetic (LSK) simulations in which we calculate the trajectories of millions of ions in the electric and magnetic fields from global magnetohydrodynamic simulations. The PSBL, separating the central plasma sheet (CPS) from the magnetotail lobes, is a dynamic and spatially complex region typically characterized by high-speed field-aligned ion beams. These beams, formed in the CPS near the reconnection region, frequently have marked velocity dispersion with the highest speed beams nearest the tail lobes. Counter-streaming ion beams are often observed closer to the CPS. Despite years of satellite observations, it is not established whether the PSBL and the ion beams within this region are always present, or only occur under special conditions. Recent observations from the Cluster and Double Star spacecraft have in fact shown that the PSBL can be a region with the expected ion beams, and can, at times, contain fine-scale sub-structures called beamlets. At other times, the transition from the CPS to the lobes is very abrupt in the observations, suggesting that the PSBL is missing. We will present simulations of plasma sheet encounters observed on Cluster and Double Star in which the MHD simulations were driven by solar wind observations. Very complex and time dependent PSBL structures result. We will present a detailed analysis of these structures that are caused by both global processes and local kinetic processes.

Keywords: plasma sheet boundary layer, ion beams

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ASIII019 **Oral Presentation** **3373**

Magnetotail Current Sheet Structures: Observations and Global MHD Simulations

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Maha Ashour-Abdalla, Jean-Michel Bosqued, Robert L. Richard

Single and multi-spacecraft observations have demonstrated that the magnetotail current sheet, one of the key dynamic regions of the magnetosphere, has significant meso-scale spatial and temporal structure. These current sheet structures are important signatures of magnetotail reconnection. In our study of an event observed by Cluster, a magnetohydrodynamic simulation showed that a great deal of structure existed in the magnetotail current and plasma pressure. Shortly after the IMF Bz reached its minimum value the current sheet exhibited areas in which regions of high plasma pressure low current density in the center of the plasma sheet that were bounded on its northern and southern fringes by thin, intense currents. At other times, almost the entire cross tail current was bifurcated. Local current filaments were often seen inside the central area of otherwise weak current. At the same time, wave like undulations across the tail can be seen in the minimum Bx component, where the current sheet maximum is normally located. As the IMF became northward a thin current sheet reformed. The association of the bifurcated current sheet, cross tail wave-like structures, localized reconnection and flux rope formation suggests that all these processes are related. The key driving conditions seem to be a substantial southward IMF rotating toward dawn. The magnetohydrodynamic simulation allows us to place the local observations into a global context.

Keywords: magnetotail, current sheet, bifurcation

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ASIII019 **Oral Presentation** **3374**

Study of relationship between turbulence in the central plasma sheet and substorm processes using the Interball-Tail satellite data

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Recent studies are shown that the turbulent processes in the space plasmas are very important. It includes the behavior of the plasma sheet plasma during geomagnetic substorms. Study of the plasma turbulence in the central plasma sheet were made using the Interball-Tail satellite data. Fluctuations of the plasma bulk velocity across the plasma sheet were studied using the measurements form the Corall instrument for quiet geomagnetic conditions and different phases of substorms and for different locations inside the plasma sheet. It was found that the plasma sheet flow always appears to be strongly turbulent, i. e. is dominated by fluctuations that are unpredictable. Corresponding eddy-diffusion coefficients were obtained as a function of the autocorrelation time and rms velocity. However, it was found that the values of eddy-diffusion coefficients increase significantly during substorm growth and expansion phases and decreases slowly to the initial level during the recovery phase. We also studied a relationship between the eddy-diffusion coefficients and the absolute value of the geomagnetic field, also measured by the Interball/Tail satellite and the plasma beta parameter. It was found that this relationship varies depending on the phase of substorm, indicating possible change in the turbulence regimen with substorm phase. Statistical studies of variation of the eddy-diffusion coefficients depending on the location inside the plasma sheet made it possible to create a three-dimensional distribution of the eddy-diffusion coefficients and compare the results obtained using the Antonova and Ovchinnikov (1998) model of the plasma sheet.

Keywords: turbulent processes

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ASIII019 **Oral Presentation** **3375**

Generation, Propagation and Interaction of Alfvenic Disturbances in Magnetotail: Theory

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Bob Lysak

Previous understanding of the dynamics of magnetotail current sheets has been limited due to the lack of a dynamical theory for the generation of electric fields and the lack of attention to mesoscale dynamical processes occurring at tail current sheets. We present here a dynamical current sheet model, i.e., a model of 3D mesoscale nonlinear interaction of Alfvenic disturbances, based on a recently-developed dynamic theory of the generation of electric fields. The nonlinear interaction between the fast mode disturbances and current sheets, or between the shear mode disturbances, can generate localized electric fields, thereby causing relevant plasma acceleration and energization. In particular, the generation of parallel electric fields can also break down the frozen-in condition locally, causing subsequent plasma and magnetic field reconfigurations. The breakdown of the frozen-in condition has a reactive nature, which is associated with 3D mesoscale interaction of Alfvenic disturbances. The characteristics and theoretical predictions of the 3D mesoscale Alfvénic interaction model will be given, which are very different from those given by the near-Earth neutral line model or the current disruption model.

Keywords: alfvenic disturbances, mhd wave, 3d mesoscale nonlinear

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ASIII019 **Poster presentation** **3376**

Energy transport, storage, and dissipation in the magnetosphere during substorms: a comparison with MHD.

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Dr. Daniel Baker, Dr. James Weygand

Magnetospheric substorms represent a global interaction between the solar wind, magnetosphere, and ionosphere. Energy transported from the solar wind into the magnetosphere is largely stored in the tail until it is released (primarily into the ionosphere and the ring current). The Akasofu epsilon parameter, and multiple empirically determined formulas for energy dissipation into the ionosphere (joule heating and particle precipitation) and the ring current have been considered for such global interactions. An energy budget and estimation of total energy in the tail has been created for 12 isolated substorms and 6 storm time substorms (Dst >-50 nT) during 2001. Considerable complexity and individuality of substorms is observed with substantial differences in the input and dissipation pattern for individual events. Our analysis is compared with previous results and MHD simulations for individual events.

Keywords: substorm, energy transfer

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ASIII019 **Poster presentation** **3377**

Implication for O+ Acceleration in the Plasma Sheet Triggered by Solar Wind Compression

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We examine an enhancement of O+ ions with energies >10 keV observed by the CIS instrument on board the Cluster spacecraft located in the magnetotail at X=-17.6 RE and Y=-4.9 RE on 24 August 2005. The enhancement is observed by SC 4 between 0904 UT and 0911 UT. For the first 1-min interval, the O+ flow direction is predominantly duskward. On 09050908 UT, peaks of pitch angle distribution are seen at 0-50 deg. and 130-180 deg. The dawnward flux is strongly enhanced at 0908 UT, when the spacecraft crosses the current sheet. Multi-point magnetic field measurements indicate that the change in magnetic field orientation propagates duskward and tailward around 0903 UT but dawnward and tailward around 0908 UT. Aurora images obtained by the IMAGE/FUV imager show no intense aurora activity during the interval. There are no clear high-energy electron flux enhancements detected at geosynchronous orbit. Solar wind observations by ACE, Wind, and Geotail imply that the high-pressure solar wind with Pd of ~55 nPa compressed the magnetotail (X~ -17 RE) from 0903 to 0908 UT. We interpret that preexisting O+ ions were accelerated by the duskward inductive electric field when Bz increased at 0904 UT. We suggest that the acceleration was triggered by the solar wind compression of the magnetotail. Cluster moved away from the central current sheet about one minute later to detect the accelerated O+ which was bouncing between both hemispheres. The strong dawnward flux at 0908 UT might be caused by the expansion of the magnetotail which could induce dawnward electric field in the plasma sheet.

Keywords: plasma sheet, oxygen ions, compression

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ASIII019 **Poster presentation** **3378**

A new general mathematical framework to explain the global properties of the substorm cycle

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We introduce a new general mathematical framework to explain the global properties of the substorm cycle, based on accessible magnetic equilibrium states of the magnetotail. The framework is shown to admit solutions consistent with both substorms and steady magnetospheric convection. The mathematical properties are derived and explored for a simplified 2-D magnetotail and compared with observations and the Minimal Substorm Model.

Keywords: substorm, model

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ASIII019 **Poster presentation** **3379**

Analysis of the substorm recovery phase using a multisatellite view and LFM MHD simulation

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Daniel Baker, Michael Wiltberger

Study of the substorm recovery phase has been relatively neglected in comparison to the much greater analyzed growth and expansion phases. It has often been assumed to be simply a transition back to the ground state magnetosphere. However, there are still important questions to be answered in regards to it, such as, Why does it start when it does? as there still appears to be free energy remaining in the lobes that could be transported earthward via reconnection. In this study we seek to understand the cause of the recovery phase by looking at a substorm event on Aug 11, 2002. We use a multisatellite view, including data from the Cluster, Polar, and Goes satellites in conjunction with the Lyon-Fedder-Mobarry magnetohydrodynamic simulation to gain a global view of the substorm. We compare data from the satellites with results from the simulation to provide support for simulations global view.

Keywords: substorm, recovery, lfm

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ASIII019 **Poster presentation** **3380**

IMF Bz dependent inner plasma sheet resulting from electric and magnetic drift transport

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Larry R. Lyons, James M. Weygand, Tsugunobu Nagai, Richard W. Mcentire

Inner plasma sheet spatial structure is essential to substorm processes and strongly dependent of the IMF. To physically relate this structure to electric and magnetic drift transport, we have investigated statistically the equatorial distributions of ions and magnetic fields from Geotail when the IMF has been continuously northward or southward for shorter or longer than 1 hr, and have used these distributions to evaluate the electric and magnetic drift paths of ions versus energy. A dawn-dusk density (temperature) asymmetry with higher density (temperature) on the dawn (dusk) side is seen in the near-Earth plasma sheet during northward IMF, resulting in roughly dawn-dusk symmetric pressure. As southward IMF proceeds, the density asymmetry weakens while the temperature asymmetry maintains, resulting in higher pressure on the dusk side. The plasma sheet is relatively colder and denser near the flanks than around midnight. The flux distributions show that the density asymmetry is due to ions < ~3 keV and the temperature asymmetry is due to ions above thermal energy. The perpendicular flow shows that ions divert around the Earth mainly through the dusk side in the inner plasma sheet due to westward diamagnetic drift. The drift paths evaluated from the observations show that, for thermal energy ions, plasma transport by magnetic drift is as important as by electric drift in the inner plasma sheet. Comparison of the distributions of the observed phase space density with the evaluated drift paths at different energies indicates that the electric drift and energy dependent magnetic drift transport is responsible for the observed dawn-dusk asymmetries in the plasma sheet structure.

Keywords: plasma sheet, electric drfit, magnetic drift

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ASIII019 **Poster presentation** **3381**

Statistical Study of Plasma Sheet Electrons and the Solar Wind

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Xinlin Li, Daniel N. Baker

The plasma sheet plays an important role in the transfer of material and energy from the solar wind to the inner magnetosphere. It is believed that the plasma sheet is the source for auroral particles, ring current particles, and outer radiation belt electrons. The mechanisms responsible for transporting and accelerating electrons from the solar wind to the plasma sheet and subsequently to the inner magnetosphere have not been well identified and understood. We present a study of the statistical relationship between plasma sheet electrons and various solar wind parameters. Electron flux measurements (40 - 100 keV) are acquired from the CLUSTER spacecraft for years 2001 - 2005, and (>38 keV) from the GEOTAIL spacecraft for years 1998 - 2006. Plasma sheet crossings were selected using the following criteria: 1) X = -30 - 0 RE, 2) |Y| < 15 RE, 3) |Bx| < 5 nT, 4) |B| < 10 nT, and 5) ion density > 0.1 cm-3. Plasma sheet electron measurements (15 minute averaged) are compared with solar wind parameters from the ACE spacecraft. One of our initial findings is that the enhancements of the electron fluxes are well correlated with solar wind speed.

Keywords: magnetosphere, plasma sheet

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ASIII019 **Poster presentation** **3382**

Statistical comparison of the energy input and dissipation in triggered and non-triggered substorms

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Hsu and McPherron [2003] and McPherron, et al., [1986] performed statistical studies to determine the frequency of occurrence of substorm triggering. They found that about 60% of all substorms can be associated with either a northward turning or a positive fluctuation in the IMF Bz while the remaining 40% occur during steady southward IMF. Hsu and McPherron [2003] demonstrated that there is no difference in the probability of triggering at any location in the IMP-8 orbit when proper account is taken for the time the spacecraft spends in each radial bin orthogonal to the Earth-Sun line. Using two satellites in the solar wind IMP-8 and ISEE-2, Hsu and McPherron [2004] found that less than 14% of all substorm triggers are not seen at both spacecraft suggesting that the hypothesis that small scale IMF structures are responsible for all substorms that appear to be untriggered is not likely to be correct. The main conclusion from Hsu and McPherron [2003] is that both triggered and non-triggered events are substorms and that the conjecture that non-triggered substorms are actually pseudo breakups or convection bays is not supported by the data. However, a surprising result obtained in this work was that triggered substorms seem to have a more obvious growth phase and a stronger magnetospheric response than non-triggered ones. This result is counter-intuitive and thus worthy of further investigation. In this report we will use a substorm onset list from 1978 to 1979 to investigate the energy loading and dissipation for both triggered and non-triggered substorms. The solar wind energy input during substorms will be evaluated by integration of epsilon or VBs during the growth phase, expansion phase, and recovery phase. The energy dissipation in the ionosphere will be estimated by integrating the AL index during the same intervals. The correlation between energy input and dissipation in different phases will be examined. The results may help us understand why previous studies have found such a difference between triggered and non-triggered substorms.

Keywords: substorm, imf, triggering

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ASIII019 **Poster presentation** **3383**

On the topology of Earthward Flux Ropes

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T.Nagai, R.Mcentire, T. Mukai

Recently a large number of Earthward-moving Flux Ropes /Plasmoids (FRs) has been demonstrated in midtail in the leading part of Bursty Bulk Flows, which were mostly identified based on magnetic variations (bipolar Bz signature combined with By peak in the CPS region) and interpreted as signature of multiple reconnection regions. Motivated by existing alternative interpretations, we investigated the behavior of energetic electrons (EE) as potential topology tracers. We identified isolated BBF onsets in the plasma sheet center with considerable Bz and |By| increases. Whereas roughly a half of them displayed a sharp EE flux increase associated with magnetic structure, in most of cases the electron flux differ strongly in the leading and trailing halfs of the flux rope, with flux increaseoften coinciding with the positive Bz (dipolarization) and density drop onsets. This can be understood if a leading half of such FR was actually composed of deformed background flux tubes, and the following half is formed by compressed reconnected flux tubes. Various behaviours observed in different eventsare shown and discussed.

Keywords: fluxropes, bbfs, plasmasheet

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ASIII019 **Poster presentation** **3384**

Plasma Waves in the Turbulent Magnetotail

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Dynamical processes in the magnetotail often involve large fluctuations of magnetic and electric fields and high speed plasma flows, which are linked to the onset of magnetospheric substorms. A variety of free energy sources associated with these processes and dissipation occurs through the growth of different type of waves. Various models of substorm onsets have included some of the effects of ULF/VLF waves. It is important to study the occurrence and properties of these waves in order to understand the roles they play in the dynamical processes. In this study we examine several high speed flow events, which are accompanied by large fluctuations of E and B fields observed by the Cluster spacecraft in the magnetotail, and investigate the occurrence of various plasma waves during the events. Preliminary results show that during these turbulent events, a broad frequency range of plasma waves is observed. They include pulses of Alfvenic waves and ion cyclotron waves, broadband whistler mode turbulence, broadband electro-static waves which are likely to be caused by electrostatic solitary waves, electrostatic waves near lower hybrid frequency, and strong electrostatic emissions near the electron plasma frequency or upper hybrid frequency. We have observed localized pulses of non-linear Alfven waves occurred in the turbulent plasma and the plasma flows became super-Alfvenic. The large amplitude of these waves suggested that they may carry substantial energy and propagating away from the source region. They may play important role in transferring energy from the tail source region towards the earth. The generation of these nonlinear Alfvenic waves needs further investigation. High frequency waves (whistler waves and various electrostatic emissions) enhanced during entire high speed flow intervals indicating that the generation of these waves are closely related to the high speed flows. The properties of some of these waves, which include the propagation direction, polarization, the wave energy they are carrying, and their relation with particles' behavior, especially for the low frequency Alfvenic waves (near or lower than the ion cyclotron frequency), will be presented and discussed.

Keywords: plasma waves

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ASIII020 **3385 - 3441**

Symposium
Magnetosphere-ionosphere interactions and auroral processes (Divisions III and II)

Convener : Prof. William Lotko

The dynamical evolution of magnetosphere-ionosphere systems is closely related to processes that mediate the exchange of mass, momentum, and energy between the ionosphere and mag-netosphere. Energetic particle fluxes, currents, and Poynting flux associated with magneto-spheric flows, plasma populations, and waves carry energy from the magnetosphere into the ionosphere. These dynamical processes can modify ionospheric conductivity and ionospheric current systems; excite plasma instabilities; and dissipate energy through collisional and wave-induced heating processes. Moreover, ionospheric modifications feed back on the magneto-sphere through alteration of the current system, radiation/reflection of waves, plasma outflow, and development of parallel electric fields to maintain quasineutrality. This symposium invites contributions on a range of areas relevant to coupling dynamics including: How do magnetospheric flows and current systems evolve when coupled to the ionosphere? What is the temporal evolution of the global ionospheric current system in the context of M-I coupling? What are the processes involved in plasma inflow/outflow, under what conditions do they occur, and how do they couple the magnetosphere and ionosphere? What role do waves and plasma instabilities play in M-I coupling? Papers presenting observations, theory, simulation and modeling are all welcome.

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ASIII020 **Oral Presentation** **3385**

Investigation of dependence of substorm effects in auroral electrojet and parameters of F-Region of ionosphere on the separate stations from ut substorm beginning on the basis of GSM TIP

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Bryukhanov Valerij Veniaminovich

In the given work the calculation results of four modeling substorms beginning in 00 UT, 06 UT, 12 UT and 18 UT for spring equinox conditions in a minimum of solar activity (F10.7 = 76) are submitted. Calculations were carried out on Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP), developed in WD IZMIRAN, with use of the new calculation block of electric fields of a dynamo and magnetospheric origins. For all four substorms the time course of auroral electrojet from which the intensity time course of westward and eastward auroral electrojet has been constructed was calculated. Calculations have shown, that during substorms there is very strong growth of westward electrojet from - 20 A/km in quiet conditions up to - 400 A/km for the substorms beginning in 00 UT, 06 UT and 12 UT, and up to - 450 A/km for the substorms beginning in 18 UT. At the same time there is a strengthening of eastward auroral electrojet intensity from ~50 A/km in quiet conditions up to 120-150 A/km for the substorms beginning in 00 UT, 06 UT and 12 UT and up to ~230 A/km for the substorms beginning in 18 UT. Calculation results well be agree with experimental data from which follows, that in quiet conditions the eastward auroral electrojet intensity is higher, than westward, and during disturbances there is auroral electrojet strengthening, and westward electrojet grows more strongly and surpasses on eastward one intensity. Global distributions of foF2 perturbations calculated for the substorm which has begun in 18 UT are submitted, and their temporal course during a substorm and after its termination is analyzed. Calculations have shown that at the substorm initial stage the positive (negative) disturbances arise in auroral zones and polar caps with maxima in post-midnight (post-sunset) hours. The absolute maximum of positive (negative) disturbances is formed in auroral zone of a southern hemisphere. Further there is a strengthening of disturbances, is especial in auroral zones and in a southern polar cap which practically is completely occupied with positive disturbances. Gradually the maximum of positive disturbances drifts from southern auroral zone to a polar cap. Negative ionospheric disturbances are observed mainly at night from subauroral latitudes up to geomagnetic equator. After the substorm termination there are negative disturbances in auroral zones at pre-midnight hours with a maximum in northern hemisphere. And the amplitude of these disturbances exceeds a disturbance range during a substorm. These disturbances are explained by action of disturbance dynamo field. Calculation results of the foF2 temporal course during substorms are submitted and analyzed for high-altitude stations Scott Base, Mawson, Leningrad, Sant Jone, Saskatoone, Meanook, Lulea, Dixon, Chatanika, Fairbanks, EISCAT, Churchil, Yellowknife, Reykjavick and Sondrestrom.

Keywords: ut variation, electrojet, substorm

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ASIII020 **Oral Presentation** **3386**

What are the ionospheric signatures of magnetotail reconnection?

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Auroral signatures have been observed for high-latitude lobe reconnection during solar wind conditions with high pressure and northward IMF. Ionospheric signatures of nightside reconnections have been reported as well. In a recent case study based on the combined Cluster and Polar PIXIE data we reported that an inverted-V structure caused by a field aligned potential drop of 30 kV producing very strong X-ray aurora was found in connection with tail reconnection. However, the insitu particle measurements by Cluster indicate clearly that the particles responsible for the X-ray aurora were not accelerated by the reconection process. Based on more than 10 Cluster passes through the reconncetion diffusion region we will determine if the particle characteristics observed by PEACE and RAPID indicate whether the reconnection process would lead to any auroral signatures. Previous results of ionospheric signatures from magnetotail reconnection will be discussed in view of these results.

Keywords: reconnection, auroralsignatures, micoupling

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ASIII020 **Oral Presentation** **3387**

The role of quiet-time thermal ion outflow in magnetosphere-ionosphere coupling during the substorm cycle

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An important unknown in our current knowledge of energetic ion outflow is the instantaneous intensity distribution of outflow during the substorm cycle. We study the influence of the IMF and convection electric field on the rate and destinations of thermal (low-energy) ion outflows at quiet times preceding a substorm, using particle tracing simulations combined with measured particle, convection, and IMF data. We find that the ions preferentially feed the dusk sector of the plasma sheet when the IMF is duskward (By > 0), and are more evenly distributed in the plasma sheet when the IMF is dawnward. The flow of oxygen to the magnetosphere is enhanced and confined to lower L-shells at times of strongly southward IMF, compared with the flow at times of northward IMF. The rate of outflow to both the plasma sheet and the magnetotail correlates strongly with the ion temperature. As a result, we believe that quiet-time outflowing thermal ions can serve as an important source of cold plasma at high altitude immediately preceding a substorm, and play an important role in the direct injection of energetic ionospheric ions into the magnetosphere during the initial phase of a substorm.

Keywords: outflow, magnetosphere ionosphere, substorm

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ASIII020 **Oral Presentation** **3388**

Auroral Arcs as Sites of Magnetic Stress Release

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An analytical model is presented for auroral arcs as the result of a fast release of magnetic shear stresses. The shear stresses are set up by a longitudinal convection that is driven by pressure forces in the outer magnetosphere against the frictional forces exerted in the lower ionosphere. A distorted-dipole geometry is employed allowing for high plasma beta near the equator. Steep ledges in the radial pressure distribution, extending along the direction of convection, are invoked as the sources of the auroral current sheets. The differential magnetic energy content of these narrow current sheets is released within a few Alfvn transit times by the decoupling of the magnetospheric plasma and field from the ionosphere, owing to the existence of field-aligned potential drops in the auroral acceleration region, and converted into kinetic energy of the primary auroral particles. A well-known current-voltage relation is employed for the formulation of the energy conversion process. This scenario has two important consequences. (1) The loss of magnetic energy creates a concomitant decrease of internal energy of the generator plasma and results in a progression of the auroral current sheet into the more highly stressed magnetic field region. (2) Plasma and field undergo a rapid, but mostly reversible stress relief motion along the arc corresponding to an essentially U-shaped potential distribution above the arc. A small S-shaped contribution to the potential results in the net displacement consistent with the transit of the field lines through the progressing current sheet. This scenario is cast into a set of simple relations expressing the key parameters of auroral arcs, such as width, energy flux, potential drop, and proper motion. Two free parameters are the relative magnitude of the pressure jump at the ledges and the plasma beta in the source plasma. Matching these relations with observed values suggests pressure jumps of order ten percent and beta values between 1 and 5.

Keywords: auroral arcs, stress release, key parametres derived

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ASIII020 **Oral Presentation** **3389**

Generation of electron-cyclotron waves by electron beam in the magnetosphere

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Broadband electrostatic noise (BEN) is commonly observed in different regions of the Earths magnetosphere, eg., auroral region, plasma sheet boundary layer etc. The frequency of these BENs lies in the range from lower hybrid to the local electron plasma frequency and sometimes even higher. Electron cyclotron waves which have been observed by the spacecrafts in polar cap, dayside cusp and auroral region are thought to be generated by low energy electron beams are studied in a four-component magnetized plasma. The model consists of three types of electrons, namely, cold background electron, warm electrons, warm electron beam and ions. The electrostatic dispersion relation is obtained for such a system and solved, both analytically and numerically for the electron-cyclotron waves. It is found that under certain conditions, the waves having frequencies near the electron-cyclotron harmonics can be driven unstable by the electron beam. The results of our investigation are applied to spacecraft observations in the magnetosphere.

Keywords: broadbandelectrostaticnoise, waves, magnetospehere

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ASIII020 **Oral Presentation** **3390**

Whistler-induced optical emission at L~5.5

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A serendipitous observation was made during a period of magnetic quieting (Kp=2) at Pomokaira in Northern Finland (L=5.31) of a bright (~100 kR) optical emission, a "spot" with a radius not exceeding 5 km, recorded by an auroral TV system, and a two-hop whistler. The whistler is interpreted to have been ducted along the outer edge of the plasmasphere (or in a duct outside the plasmapause) at L~5.510.07, the equatorial plane electron density being 492 cm-3. A gyroresonant interaction takes place at, or close to, the magnetic equator on this L-shell, reducing the pitch angles of energetic electrons, and putting them into the loss cone. At the highest whistler frequency observed, 1.7 kHz, the component of the gyroresonant energy parallel to the geomagnetic field is 1.7 keV and, at the lowest, 0.5 kHz, almost 14 keV. The essential coincidence of these two events, which lasted 4 s in total, and their detailed timings, can be satisfactorily explained by the half-hop whistler travel time from the northern hemisphere to the equator, and by one quarter of the the electron bounce time from the equator to the northern auroral atmosphere. Diffuse aurora was also observed more or less continuously during the same evening.

Keywords: optical emission, whistler, wave particle interaction

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ASIII020 **Oral Presentation** **3391**

Features of the magnetosphere-ionosphere coupling via Alfven waves at auroral latitudes

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Two salient features of the auroral topside ionosphere are the occurrence of (a) the auroral acceleration region (AAR) which is characterized by a mirror resistance and a related electric potential drop; and (b) a resistive turbulent layer (TL) with anomalous conductivity caused by high-frequency turbulence. An analytical treatment of the interaction of Alfven waves with the combined magnetosphere - AAR/TL - topside ionosphere - E-layer system immersed into a converging dipole-like magnetic field has been made. The rate of wave reflection/transmission is estimated to be critically dependent on the ratio between the wave transverse scale and the Alfven resistive scale, thus performing a scale-dependent magnetosphere-ionosphere coupling. Magnetospheric Alfven waves penetrating into the AAR can produce oscillatory variations of the field-aligned potential drop and field-aligned electron acceleration. Modeling of the spatial spectrum of an Alfven burst by a power-law dependence indicates that the rate of wave power absorbed by the AAR might be significant, up to 30-50%. Thus, modeling results confirm that Alfven waves can produce auroral activation. Estimates of the resonance width of ULF oscillations of a field line with AAR show that the mirror-force mechanism can dominate over ionospheric dissipation and dispersive effects. A resonator in the topside ionosphere between the E-layer and the bottom boundary of AAR can also occur. This resonator can trap Alfvenic disturbances with frequencies ~0.1 Hz (i.e. lower than that of the known ionospheric Alfven resonator) and with transverse scales from km to a few tens of km. The Alfven wave interaction with a TL is also characterized by the resistive scale , but determined by the field-aligned resistance. The thin TL model has been applied to the interpretation of the results of transient Pi2 pulsation damping studies, which showed that the damping rate increased for accompanying magnetic bays stronger than 100 nT. This additional damping can be caused by the occurrence of anomalous transverse resistance when the magnetospheric current exceeds the threshold necessary for the excitation of high-frequency plasma turbulence. Stochastic fluctuations of the of the Alfven resonant frequency can cause an additional damping of Alfven field line oscillations and deterioration of resonator properties.

Keywords: alfven waves, turbulence, aurora

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ASIII020 **Oral Presentation** **3392**

Response of the magnetosphere and ionosphere to CME events

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RESPONSE OF THE MAGNETOSPHERE AND IONOSPHERE TO CME EVENTS N. Balan(1), H. ALLEYNE(1), I. McCrea(2) and B. G. Fejer(3) (1)Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK. (2)Rutherford Appleton Laboratory, London, UK. (3)Utah State University, USA. The responses of the magnetosheath-cusp region and global ionosphere to the CME events during 07-12 November 2004 are presented using Cluster and ground-based observations and modeling. In response to two long-lasting CME clouds that flowed passed the Earth during 07-11 November 2004, a rare super double geomagnetic storm with three positive initial phases occurred. The magnetospheath-cusp region responded strongly to the changes in the dynamic pressure of the CME clouds and IMF By and Bz. The high latitude ionosphere over EISCAT responded directly to the CME pulses while the response of the low-mid latitude ionospheric density (NmF2 and TEC) was delayed until the main phase (MP) onset of the geomagnetic storm though the initial positive phase lasted for about 18 hours when hmF2 increased. These responses indicate shielding effect, absence of penetrating electric fields during the initial phase of this particular storm, and storm-time equatorward neutral wind reaching the low-mid latitude ionosphere before MP onset. After MP onset, the low-mid latitude ionospheric density (NmF2 and TEC) showed strong positive ionospheric storms in the Australian-Japan longitudes (120-145E) and negative ionospheric storms in American (60-120W) longitudes. The Cluster spacecraft and incoherent scatter radar observations showed mapping of magnetospheric electric fields to the high latitude ionosphere and its penetration to low latitudes; the strongest ever recorded penetration occurred on 09 November 2004, with an efficiency of about 10% (EISCAT and Jicamarca data are available only after MP onset). In response to the strong penetrating eastward electric field, an additional layer (F3 layer) over the equator quickly ascended to the topside ionosphere. The low-mid latitude ionospheric responses are modeled using the Sheffield University Plasmasphere Ionosphere Model. -- 1. Session Code: ASII20 2. Title : Magnetosphere-ionosphere interactions and auroral processes 3. Key words: CME event, geomagnetic storm, ionospheric storm 4. N. Balan, Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK Tel: +44-114-222-5234; Fax: +44-114-222-5661 E-mail: b.nanan@sheffield.ac.uk 5. Oral 6. PC 7. No 8. No

Keywords: cme event, geomagnetic storm, ionospheric storm

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ASIII020 **Oral Presentation** **3393**

Field-aligned acceleration of plasmas in midnight sector by slow mode wave: Pi2 band modulation of aurora in all-sky image

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It has been suggested that earthward acceleration of plasmas along field lines can be generated by slow mode waves preferentially from structures with short perpendicular scales [Saka et al., 2005; Saka, 2006]. The field-aligned accelerations, F_z, by slow mode waves at the equatorial plane may be given by the relation, F_z=A div(b_p). Here, A is a coefficient determined by pressure anisotropy, and plasma beta. Expression defined by div(b_p) is a divergence of the first order field line vectors perpendicular to the backgrounds. We estimated div(b_p) associated with surface waves in Pi2 band by using magnetometer data of two geosynchronous satellites (GOES5 and GOES6) separated by two hours of local time in the magnetosphere. We show that surface wave may couple to slow mode waves in auroral breakup region. Modulations of auroral intensification in Pi2 band as observed by all-sky image at conjugate ground station can be predicted by the simple relations given above. References [1] O.Saka, S.Fujita, and D.N. Baker, Adv.Polar Upper Atmos.Res., 19, 84 (2005). [2] O.Saka, Adv.Polar Upper Atmos.Res., 20, 38 (2006).

Keywords: field aligned acceleration, slow mode wave, aurora

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ASIII020 **Oral Presentation** **3394**

High-Latitude Plasma Convection From Cluster EDI Measurements

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We have used vector measurements of the electron drift velocity made by the Electron Drift Instrument (EDI) on Cluster between February 2001 and March 2006 to derive statistical maps of the high-latitude plasma convection. The EDI measurements, obtained at geocentric distances between ~4 and ~20 RE over both hemispheres, are mapped into the polar ionosphere, and sorted according to the clock-angle of the interplanetary magnetic field (IMF), measured at ACE and propagated to Earth, using best estimates of the orientation of the IMF variations. Only intervals of stable IMF are used, based on the magnitude of a "bias-vector" constructed from 30-min averages. The resulting data set consists of a total of 5862 h of EDI data. Contour maps of the electric potential in the polar ionosphere are subsequently derived from the mapped and averaged ionospheric drift vectors. Comparison with published statistical results based on Super Dual Auroral Radar Network (SuperDARN) radar and low-altitude satellite measurements shows excellent agreement between the average convection patterns, and in particular the lack of mirror-symmetry between the effects of positive and negative IMF By, the appearance of a duskward flow component for strongly southward IMF, and the general weakening of the average flows and potentials for northerly IMF directions. This agreement lends credence to the validity of the assumption underlying the mapping of the EDI data, namely that magnetic field lines are equipotentials. For strongly northward IMF the mapped EDI data show the clear emergence of two counter-rotating lobe cells with a channel of sunward flow between them. The total potential drops across the polar caps obtained from the mapped EDI data are intermediate between the radar and the low-altitude satellite results.

Keywords: convection, ionosphere, magnetosphere

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ASIII020 **Oral Presentation** **3395**

Generation of intense quasistatic fields at high altitudes by the ionospheric Alfvn resonator

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The ionospheric Alfvn resonator (IAR) is a lossyelectromagnetic cavity that retains energy in the form of 1-10 sec Alfvn waves standing between the bottomside conducting layer and the effective discontinuity in refractive index created by the typically steep gradient in Alfvn speed in the low-altitude magnetosphere. Properties of the IAR including active ionospheric pumping by feedback instability have been studied extensively for conditions in which the ionosphere may be considered homogeneous in the transverse direction.We have analyzed the feedback instability of the IAR in the presence of transverse inhomogeneity in the context of both a simple, semi-analytic model and full-wave, numerical simulations in dipole magnetic geometry with realistic distributions for the Alfvn speed, background currents and fields, and ionospheric conductivity dynamics. We consider a system of paired upward/downward field-aligned currents of finite transverse extent that close via Pedersen currents in the ionosphere. The horizontal transport of IAR modes from the downward to upward current channelhas two important consequences: 1) amplification of feedback-unstable IAR modes is stabilized by loss of frequency synchronization as they approachthe current reversal from the region of instability in the downward current channel; and 2) the upper IAR boundary becomes increasingly lossy with the decrease in frequency and associated increase in parallel wavelength of the decelerating IAR modes. The latter effect allows the IAR-come-quasistatic fields to penetrate to high altitudes in the magnetosphere. These results add new insights into electric and magnetic field measurements obtained from the FAST, Cluster and Polar satellites when traversing the plasmasheet-polar cap boundary region.

Keywords: alfvnic, magnetosphere ionosphere, coupling

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ASIII020 **Oral Presentation** **3396**

Electric field and undulations in the evening diffuse auroral zone

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The subauroral polarization stream (SAPS) is a region of fast westward plasma drift equatorward of the auroral electron precipitation zone covering the evening-midnight sector. We present data from the event of December 12, 2004 to study the generation conditions of intense electric fields responsible for SAPS formation. Ground-based ionospheric and optical measurements at Tixie (71.6 N, 128.9 E, L=5.6) were supplemented by DMSP (F13, F14, F15) data when the foot of satellite field line passed near Tixie. During the event, magnetic activity was moderate (Êð = 4 and Dst = -40 nT). The appearance of the north-directed electric field was almost synchronously detected by both ionospheric (~0900 UT) and DMSP F15 (~0910 UT) measurements in the evening sector (18-19 MLT). The maximum intensity of electric field and diffuse undulations were localized near a discrete auroral arc related to the electron inverted-V structure. In contrast to the typical SAPS event, on the basis of DMSP satellite data the westward plasma stream with large velocities (0.5-0.8 km/s) was located in the energetic (>1 keV) ion and electron precipitation zones, i.e. not in the region of main ionospheric trough. According to DMSP F13 and F14 data, undulations with the wavelength of 200-300 km and amplitude of ~50-150 km propagated with the velocity of ~0.5 km/s to the west. The parameters of the undulations by optical and satellite measurements are in close agreement. The possible mechanisms to generate the electric fields in the diffuse proton aurora zone are discussed. This work was supported by RFBR grant 06-05-96118, by the Program of Presidium of RAS no.16 p.3 and by INTAS grant 06-1000013-8823.

Keywords: saps, undulation, diffuse auroral zone

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ASIII020 **Oral Presentation** **3397**

Peculiarities in plasmaspheric thermal structure as observed by INTERBALL satellites

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Cold plasma measurements onboard Interball 2 (1996) and its sub-satellite MAGION 5 (1999-2001) were used to examine ion temperature variations in the Earths plasmasphere during magnetically quiet and moderately disturbed times. Field aligned comparison of plasmaspheric ion temperatures with electron and ion temperatures measured by DMSP satellites in the upper ionosphere (~ 840 km) showed new features in plasmasphere ionosphere coupling. In the inner plasmasphere at L = 2.5 2.8, ion temperatures were close to electron temperatures in the upper ionosphere everywhere except for the noon-to-dusk MLT sector. At higher L (L > 3), the plasmasphere-to-ionosphere temperature ratio was greater than 1, and there was also an increase in the 12 20 MLT sector. Apparently there is a heating source at high L that is strongest in the noon-to-dusk MLT sector.A study of the temperature behavior during moderate magnetic storm development revealed that night time ion temperature was depressed in the storm main phase, but exceeded quiet time values in the storm recovery phase. Possible reasons of such temperature behavior are discussed. This work was partially supported by Programs P16/2 and OFN 16 of Russian Academy of Sciences.

Keywords: plasmasphere, ionosphere, heating

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ASIII020 **Oral Presentation** **3398**

On the formation and motion of transpolar arcs

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We present auroral and ionospheric flow observations from several occurrences of transpolar arcs or theta aurora. We conclude that transpolar arcs can be formed by episodes of magnetic reconnection in a twisted magnetotail, producing regions of closed magnetic flux which protrude into the otherwise open polar cap. Subsequent motion of such arcs dawnwards or duskwards is governed by reconnection at the magnetopause changing the distribution of open flux in the polar cap and magnetotail lobes. During northward interplanetary magnetic field, lobe reconnection can siphon open flux from one side of the arc to the other; during southward IMF new open flux can be added preferentially to one side of the arc or the other.

Keywords: transpolar arcs, magnetic reconnection

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ASIII020 **Oral Presentation** **3399**

Multi-point observations of field-aligned currents from Space Technology 5

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Space Technology 5 (ST5) is a three micro-satellite constellation deployed into a 300 x 4500 km, dawn dusk, sun synchronous polar orbit on March 22, 2006. Each spacecraft carried a miniature tri-axial fluxgate magnetometer (MAG). The spacecraft were maintained in a pearls on a sting constellation with controlled spacings ranging from just over 5000 km down to under 50 km. Although the short 90-day mission was designed to flight validate new technologies, the constellation mission returned high quality magnetic field data as they flied in formation and made simultaneous multi-point measurements of the magnetic field through Earths dynamic ionospheric current systems. During the three-month mission duration, a substantial volume of magnetic field data was taken over a range of inter-satellite spacing. These separations allow us to separate spatial versus temporal structures of auroral field-aligned currents over a wide range of spatial (~ 50-4000 km) and temporal (~ 5 s-10 min) scales. We report results of magnetic field measurements of field-aligned currents using ST5 data.

Keywords: field aligned currents, ionosphere

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ASIII020 **Oral Presentation** **3400**

Ionospheric storm-time convection as seen by GPS tomography and in-situ spacecraft observations

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The global pattern of the ionospheric plasma convection can be deduced from characteristics of GPS signals acquired by ground-based network of GPS receivers. A novel algorithm for ionospheric plasma GPS tomography based on Kalman filtering has been developed by the University of Bath group. This algorithm has been applied to reconstruct the 4D dynamics of ionospheric plasma content (TEC) and density during some major magnetic storms of the recent solar maximum. Comparison between the results of GPS tomography and in-situ measurements of plasma bulk motion by LEO DMSP satellites allow conclusions to be made about the degree at which the ionospheric convection flow expands during the major storms and the efficiency of electromagnetic magnetosphere-ionosphere coupling at sub-auroral latitudes.

Keywords: gps, tomography, convection

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ASIII020 **Oral Presentation** **3401**

Alfven wave resonance cones and ionospheric outflow

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It is now well established that shear Alfven waves (SAWs) dump a large amount of electrognatic power in the topside auroral ionosphere. How is this energy dissipated? Obervations also show that theSAWs have latitudanally narrow structures. How are such narrow (filamentary) structurescreated from SAWs having long transverse wavelengths created in the distant parts of the magnetosphere? We report that when long wavelength SAWsencounter localized density cavities, they induce electric dipoles inthe cavities due to the divergence in the ion polarization current. The dipoles radiate narrow structures of Alfven waves like the inertial Alfven waves detected from Freja, FAST and Polar. The radiated wave patterns are the Alfven wave resonance cones. As demonstrated by sevaral satellite and rocket experiments, the narrow structures of the inertial Alfven waves are effective in transverse ion heating. The density cavities themselves might be generated by double layers, which are an integral part of the auroaral acceleration processes. Thus we discuss the entire chain of processes involved in the dissipation of SAWs; the chain involves SAWs as the source of energy, the localizedplasma density cavities, generation of nature made electric dipole antennas in the cavities, radiation of short scale inertial Alfven waves, whichfacilitate the transferof electromagnetic energyinto the kinetic energy of the plasma ions. Results from theory, simulations and observations will be presented.

Keywords: alfven, wave, cones

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ASIII020 **Oral Presentation** **3402**

Relation of Substorm Onset to Harang Discontinuity

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In this study we investigate the relation of auroral substorm onsetto the Harang discontinuity. Various studies have reported that thesubstorm onset occurs poleward, equatorward, or within the Harangdiscontinuity. The motivation for the present study is to furtherinvestigate this relation with a much larger database. Using adatabase of over 3700 onsets determined from auroral images takenon the Imager of Magnetopause-to-Aurora Global Exploration (IMAGE)spacecraft we statistically examine the magnetic latitude and MLTlocation of the onset with respect to the location of the Harangdiscontinuity. This discontinuity is determined with data from theInternational Monitor for Auroral Geomagnetic Effects (IMAGE) groundmagnetometer network. We define the location of the Harang discontinuityas the transition from eastward to westward equivalent ionosphericcurrents at the latitude of the main auroral electrojet flow. Thiswork attempts to determine whether the substorm onset always occurswithin the ionospheric Harang discontinuity as proposed by Lyons etal. [2003]. Our initial results show that for more than 75 eventsthat occurred above the IMAGE ground magnetometer array about 26(35%) occurred within 6 of latitude of the Harang discontinuityobserved during the growth phase of the substorm and 33 (44%) occurwithin 5 of latitude of the Harang discontinuity observed duringthe expansion phase of the substorm. We also find that 21 (28%) ofthe auroral onsets occur in association with vortices of equivalentionospheric current observed during the growth phase and 41 (55%)of the onsets occur near equivalent ionospheric current verticesobserved during the expansion phase. The remaining 25 (33%) onsets donot appear to be associated with a simultaneous Harang discontinuity ora vortex during the growth phase and 14 (19%) of the onsets are notassociated with either phenomena during the expansion phase. Ten (13%)of the initial 75 onsets are most likely misidentified substorms.One of the primary goals of this study is to test the statement inLyon et al. [2003] that the substorm onset occurs within the Harangdiscontinuity. We have found that 26 of the initial 75 onsets occurwithin or near the classical Harang discontinuity identified in thegrowth phase.

Keywords: substorm, harangdiscontinuity

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ASIII020 **Oral Presentation** **3403**

Variation of the cold plasma density structure above the polar ionosphere associated with geomagnetic storms

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Plasma outflow from the polar ionosphere is one of the most important processes in the magnetosphere-ionosphere coupling in the polar region. Recent observations have clarified that the plasma outflow takes an important role on the supply of plasma into the magnetosphere, changes of the ring current ion composition, and the formation of auroral acceleration region during geomagnetic storms. Laakso and Grard, [2002] showed that the plasma density increased more than one order of magnitude during magnetic disturbed periods. However, these studies have not been focused on the variation during geomagnetic storms. In order to clarify the physical process of an abrupt change of the plasma density structure during geomagnetic storms, we analyzed the electron density data observed by the Akebono satellite in an altitude range from 300 to 10500 km. The electron density was derived using dynamic spectra of upper-hybrid wave (UHR) observed by the PWS on-board the Akebono satellite. The upper cut-off frequencies of the whistler mode waves were used for the case when the plasma frequency was smaller than the cyclotron frequency. In the present study, we used the data from March, 1989 to July, 1990. These electron density data were sorted into two geomagnetic conditions. These are magnetically quiet condition and storm main phase period based on SYM-H and Kp indices. The geomagnetic storm is defined when SYM-H decreased less than -40 nT. The main phase of the geomagnetic storm is defined as the period when the time derivative of SYM-H shows negative value. The quiet time is defined as the period when SYM-H is in the range from -10 to 40 nT and at the same time, Kp is less than 2+ for previous 3 hours. We analyzed storm time events on June 6, June 9, August 10, September 26, and November 17, in 1989. In these events, plasma density enhancements were clearly associated with the storm main phases. In the June 6 storm, the electron density enhanced up to 100 times as large as the prestorm level. Using the data from March, 1989 to July, 1990, we compared the electron density distribution during the magnetically quiet time and the storm main phase. Enhancement of the storm-time density showed a seasonal dependence. The electron density increased 3 (in summer) to 10 (in winter) times higher than the quiet time average. It is inferred that the enhancement of the electron density is associated with the intense ion upflow in the cusp and auroral regions during geomagnetic storms drifting in the polar region by the two-cell convection. During geomagnetic storms, a large amount of the ionospheric plasma would be supplied to the 10000 km altitude in the magnetosphere.

Keywords: plasma density, plasma outflow, geomagnetic storm

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ASIII020 **Oral Presentation** **3404**

On estimating low-energy spectral information due to daylit auroral arcs using combined optical and radar measurements from Sondrestrom

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R. Doe

Estimating energetics of particles incident into the ionosphere thermosphere system is an essential step which will eventually enable our understanding of the coupling between Magnetosphere-Ionosphere-Thermosphere (MIT) system. So far, estimates of particle energies and fluxes have been carried out from Space-borne measurements, coupled ISR and modeling techniques, and by nighttime optical emissions at some strategic wavelengths. However, estimating the low-energy spectral information during daytime has remained a challenge as the combined ISR E-region/ inverse techniques estimate particle spectra at energies approximately above 600 eV, satellite measurements do not provide time resolution, and optical measurements have so far been confined to the nighttime. A high spectral resolution imaging instrument, called HIRISE has been built at Boston University which is capable of making ground based measurements of daytime optical emissions. Hence, it is now possible to investigate MIT coupling round-the-clock. We commissioned HIRISE spectrograph at ISR facility in Sondrestrom for round-the-year optical measurements. The brightness calibrated HIRISE OI 630 nm emissions show excellent agreement with the ISR/GLOW estimates and with those measured by the nighttime all-sky OI 630 nm imager operating at the same location.We have evolved a methodology to estimate low-energy particle flux by combined use of HIRISE measurements and forward modeling of ISR/GLOW emissions. We compare the GLOW model predictions constrained by the ISR (Ne, Te) measurements with the measured HIRISE emissions. The difference between the HIRISE measured and the ISR/GLOW emissions are due to low-energy particle fluxes. For soft arcs we obtain the hmF information from the ISR-Ne profiles and from the Rees modeled mono-energetic production profiles we obtain Eo. Assuming that the excess HIRISE emissions are due to precipitating electrons with Maxwellian distribution at this Eo, we now vary the E-flux as a free input to GLOW in order to match with the HIRISE redline emissions. Some of the first results on different days will be presented and discussed.

Keywords: daytime aurora, 630nm, mit coupling

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ASIII020 **Oral Presentation** **3405**

Coordinated ground-based and satellite observations of magnetosphere-ionosphere coupling process

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Coordinated ground-based and satellite observations are of great importance for understanding the electrodynamics of magnetosphere-ionosphere coupling process as a function of geomagnetic activity. An example of these dynamic coupling processes is the ionospheric ion outflow events emanating from the ionospheric cusp region all the way to the magnetosphere. In this presentation, we present coordinated ground-based and satellite observation results showing examples of this magnetosphere-ionosphere coupling process. This includes the dayside low-energy ion outflow event that occurred on 16 December 2003. A tomographic reconstruction technique has been applied to the GPS TEC data obtained from the GPS receiver on the FedSat LEO satellite. This is the first two-dimensional tomographic image of the topside ionosphere and plasmasphere that reveals a spectacular beam-like flux tube structure of ionospheric ion outflow from 0.13 Re up to 3.17 Re altitude. Storm enhanced density (SED) feature observations in longitudinal sectors other than North American sector will also be discussed in this talk. Previously, SED signatures were only observed over North America, which led to the hypothesis that the equatorward offset of the geomagnetic pole at those longitudes play a major role for the SED formation in this region. Correlating the ground-based (GPS TEC and ISR) and low-altitude (JASON, TOPEX, and DMSP) observations with space-based imagery of the high-altitude plasmasphere (from the NASA IMAGE spacecraft) reveals that these SED features result from the erosion of the outer layers of plasmasphere by intense sub-auroral electric fields. The SED features extend many Earth radii into space, spanning our atmosphere from the lower ionosphere to the outer limits of the magnetosphere.

Keywords: ion outflow, plasmaspheric plume, mi coupling

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ASIII020 **Oral Presentation** **3406**

Initial results from the SuperDARN Hokkaido radar observation: Nightside ionospheric convection in mid-latitudes during magnetic storms

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SuperDARN Hokkaido radar started the observation of the mid-latitude ionospheric plasma convection since the beginning of December 2006. We report some initial results about the ionospheric convection in mid-latitudes during major storms. So far three major storms has been observed: Dec. 6, 2006 (CIR-driven, -77nT); Dec. 15, 2006 (CME-driven, -187 nT); and Jan. 29, 2007 (CIR-driven, -76 nT). Nightside convection flow was observed around the magnetic latitude of 55-65 degreesduring the main phase of the CIR storms. The new observation datacan give new insights for understanding of the complicatedM-I coupling process during storms.It is expected that the unexpected ionospheric echoesmight be discovered at even lower latitudes during larger storms.

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ASIII020 **Oral Presentation** **3407**

Multi-point Observations of Field-Aligned Currents in the Polar Ionosphere

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The three ST5 spacecraft were launched in Spring 2006 into a sun-synchronous low altitude (4000 km apogee) polar orbit with a pearls on a string configuration. The spacecraft acquired just over three months of high resolution magnetic field data, and thus they provided multipoint observations of field-aligned currents (FACs) in the polar ionosphere allowing for the discrimination of temporal versus spatial structure. The ST5 observations also complement the observations of FAST, which is in a similar orbit to the ST5 spacecraft, although the FAST orbit precesses in local time. Data from several close conjunctions between ST5 and FAST show both small-scale variability and large-scale persistence in FAC structure. Furthermore, FAST includes particle detectors that allow us to determine the different types of current-carriers. In particular, FACs are carried by keV energy electrons (inverted-V), low energy upgoing electrons from the ionosphere (return currents), and wave accelerated electrons (Alfvenic aurora). Thus FAST can provide additional information that can be related to the temporal and spatial FAC structures observed by ST5. Last, we also make use of global simulations to place both the FAST and ST5 observations into a global context. In particular, such comparisons will allow us to discriminate between externally-driven variability, such as changes in FAC morphology and intensity related to changes in the solar wind, and internally-driven variability.

Keywords: polar, ionosphere, currents

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ASIII020 **Oral Presentation** **3408**

Electron acceleration along the geomagnetic field due to inertial Alfvn waves

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Robert Rankin

Shear Alfvn waves can accelerate electrons along a magnetic field when their perpendicular scale lengths are short. We investigate the range of favourable conditions for electron acceleration along realistic geomagnetic field lines using a self-consistent kinetic simulation code. We focus on the electron response to the shear Alfvn wave in the inertial regime, where the electron thermal speed is less than the Alfvn speed. This regime is appropriate for the region at 2-3RE radial distance from the Earth, where auroral electron acceleration is likely to take place. A parameter study of this wave-particle interaction demonstrates how wave amplitude, perpendicular scale length and the form of the ambient electron distribution function can all influence the number and energy of accelerated electrons. We compare the size of the parallel electric field obtained in the simulation to theoretical predictions, since this parameter is often difficult to obtain from in-situ measurements. The simulation results are compared with observations from rocket campaigns and spacecraft to demonstrate the minimum physical conditions required to explain the details seen in the data.

Keywords: aurora, acceleration, simulation

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ASIII020 **Oral Presentation** **3409**

The polar ionosphere-thermosphere: a system in flux

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The polar ionosphere-thermosphere (IT) in the 80-200km altitude range is subject to fluxes of energy from a variety of distant sources. The solar flux and the magnetosphere electromagnetic and kinetic energy fluxes are the primary sources with their relative importance dependent on geomagnetic activity and the spatial and temporal scales of interest. The behavior of the IT system below 200 km is strongly height dependent with vertical and horizontal gradients that persist in almost every basic property describing the thermospheric neutral gas and ionospheric plasma. Sources of energy are required to sustain these neutral and plasma structures, and, once created, these structures can lead to a redistribution of energy, mass and momentum. Here, we apply observations of the polar IT system to illustrate the impact of magnetospheric sources on the structure of the polar ionosphere electron density, electron temperature and ion temperature and to relate these observations to electromagnetic and kinetic energy sources.

Keywords: polar, thermosphere, ionosphere

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ASIII020 **Oral Presentation** **3410**

Evolution of Electric Fields in the Subauroral Region of the Ionosphere and Magnetosphere

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During geomagnetic activity, coupling between the ring current and sub-auroral ionosphere (via region 2 Birkeland currents) can create ionospheric electric fields--either enhancements such as the subauroral polarization stream (SAPS), or shielding--that have a dramatic effect on the dynamics of the plasmas of the inner magnetosphere. We compare the output of a simple computational model of the plasmasphere to observations, both remote sensing by the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite and in situ by the geostationary satellites of the Los Alamos National Laboratory (LANL). These comparisons clearly demonstrate the need to include this region 2 coupling system. Observations during substorms and mild convection enhancements imply that there is a finite speed for the effects of substorms and convection to propagate through the inner magnetosphere, and that this propagation can create turbulent-like flow bursts and undulatory motions at the plasmapause boundary. We show that these effects are a consequence of the finite speed of plasma responding to subauroral convection.

Keywords: plasmasphere, electricfields, magnetosphere

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ASIII020 **Oral Presentation** **3411**

Vlasov Simulations of Dispersive Field Line Resonances

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Clare Watt

It is well established that Pc5 ULF field line resonances (FLRs) are associated with modulations of the optical aurora, as demonstrated by numerous observations made using meridian scanning photometers and all-sky cameras. Discrete auroral arcs appear in association with FLRs, implying the existence of a parallel electric field that is strong enough to precipitate electrons to energies ranging from 100's of eV to a number of keV. Parallel electric fields in FLRs exist when the perpendicular scale of the waves is comparable to the electron skin depth and/or the ion acoustic or ion gyroradius. However, it can easily be demonstrated that for low frequency FLRs, with frequencies in the range of a few mHz, two-fluid MHD theory estimates of parallel electric fields in FLRs are too small (by more than an order of magnitude,) to explain the electron precipitation that is observed in association with FLRs. The reason is that two-fluid theoryunderestimates electric fields because of the nonlocal nature of the current-voltage relation in FLRs. This requires a fully-kinetic treatment that by-passes the the generalized Ohm's law relating the field-aligned current and parallel electric field. Using a 1D Vlasov-Maxwell simulation code, we consider the excitation of FLRs covering the frequency range of a few mHz.. We calculate the parallel electric field kinetically, and consider its effect on the distribution function of electrons. In this way, we are able to provide quantitative estimates of the electron precipitation, and demonstrate that it is sufficient to explain temporally modulated disvcrete arcs with periods ranging over a few 10's of minutes.

Keywords: discrete auroral arcs, field line resonances, vlasov maxwell simulations

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ASIII020 **Oral Presentation** **3412**

Cowling Channel Formation Model in the 3D-Ionosophere

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Cowling channel formation mechanism in the 3D-ionosphere using two-current layer model of Hall and Pedersen current is proposed. In the earths ionosphere, formation of Cowling channel is quite universal phenomena in which a continuity of Hall current generated by the magnetospheric and atmospheric dynamo is broken by non-uniform Hall conductance. In the high-latitudinal regions, horizontal gradient of Hall conductance becomes a necessary condition for Cowling channel formation and vertical gradient of Hall conductance also becomes important in the low and mid-latitudinal regions. Although generation mechanism of Cowling channel is different between the high latitudinal region and the low-mid latitudinal regions, their primary structure and energy circulation role has following universality; (1) . The Cowling channel is essentially formed by the upper Pedersen current layer and lower Hall current layer, which are connected through a field-aligned current. The channel is composed of a pair of two current systems; one is 3D-Cowling current directly coupled to the dynamo region and the other is 3D-meridional current, which encircles Cowling current system. (2) . For preserving the Cowling channel, the Cowling current system absorbs electromagnetic energy from generator and supplies holding energy of meridional current system. In each current system, Pedersen current layer becomes an energy sink, while Hall current layer acts as an energy sink in the Cowling current system and as an energy source in the meridional current system. (3) Connection between Pedersen current layer and Hall current layer through the field-aligned current is indispensable condition for describing Poynting vector between energy sources and energy sinks. In this paper, we will show that in addition to the well-known substorm-auroral electrojet and equatorial electorjet, Sq-current system in the low and mid latitudinal ionosphere is also a result of formation of Cowling channel system. We also discuss about universality of Cowling channel formation in the 3D-ionosphere.

Keywords: cowling channel, field aligned current, hall current dvergence

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ASIII020 **Oral Presentation** **3413**

Dual structure of auroral acceleration regions at substorm onsets as derived from AKR spectra

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Two sources of auroral kilometric radiation (AKR) and their development prior to and during substorms were derived from high-time-resolution spectrograms provided by Polar/PWI ac electric field observations and were investigated in connection with the auroral acceleration process. One source is a low-altitude source region corresponding to middle-frequency AKR (MF-AKR), and the other is a high-altitude source region corresponding to low-frequency AKR (LF-AKR). The former appears during the substorm growth phase in the altitude range of 4000-5000 km and is active both before and after substorm onset. A few minutes before the onset, the intensity of this source gradually increases, showing precursor-like behavior. It does not change drastically at the onset and is mostly insensitive to it. At Pi 2 onset, in contrast, high-altitude AKR appears abruptly with intense power in a higher and wider altitude range of 6000 to 12,000 km. The increase in its power is explosive (increasing 1000 times within 20 seconds), suggesting the abrupt growth of the parallel electric fields that cause bursty auroral electron beams. The statistically derived probability of both sources existing at substorm onset is ~70%, indicating that this duality of AKR sources is a common feature of substorms. The high-altitude source and related transient acceleration at substorm onset is apparently due to 1) intrinsically local instabilities such as current-driven instabilities, or 2) transient short wavelength Alfvn waves. The low-altitude source, which is fairly stable and insensitive to substorm onset, may belong to the global quasi-static potential distribution over the auroral oval, which involves a large-scale inverted-V structure and a quasi-steady field-aligned current.

Keywords: substorm onset, field aligned acceleration, m i coupling

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ASIII020 **Oral Presentation** **3414**

Downward-directed field-aligned currents and electric fields and their role in magnetosphere-ionosphere coupling processes associated with aurora

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The downward field-aligned current region plays an active role in magnetosphere-ionosphere coupling processes associated with aurora, as demonstrated by high-resolution measurements from Freja and FAST. These revealed a rich variety of phenomena, such as quasi-static electric field structures with a downward parallel electric field, double layers, narrow upward accelerated electron beams, ion conics, electron solitary waves, low-frequency wave activity, and plasma density cavities. Later on Cluster auroral observations added new insight into the dynamics and characteristics of the return current region, as will be exemplified by results from event and statistical studies. The quasi-static electric fields are often monopolar or bipolar, the monopolar fields occurring at sharp boundaries such as the polar cap and the bipolar fields at boundaries within the plasma sheet. Correlations studies indicate a higher degree of local current closure for the bipolar structures than for the monopolar structures. Relationships are presented between the electric field magnitude, potential, scale size and the way these depend on the activity level, conductivity, and location. The temporal evolution of quasi-static electric field structures, as captured by the pearls-on-a-string configuration of the Cluster spacecraft for a series of events, indicate that the formation of the electric field structures and of ionospheric density cavities are closely tied to each other. Numerical simulations of the return current dynamics demonstrate that relatively intense ionospheric electric fields map, during certain conditions, to high-altitudes, i.e without a parallel potential drop forming in the intermediate region. Preliminary studies of the mapping of electric fields in the downward current region, suggest that the degree of mapping depends on the evolutionary state of the electric field structures which is closely tied to the plasma conditions along the flux tube of the structure.

Keywords: aurora, acceleration, cluster

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ASIII020 **Oral Presentation** **3415**

Multipoint observation of Ps6 events

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Reshetnik Volodymyr

Ps 6 events in the Earth magnetosphere tail display themselves as localised in time wave pockets, with filling wave periods in range of 5 - 20 minutes. Their generation is often considered to be part of the substorm recovery phase. Our study of Ps 6 event evolution dynamic demonstrates that Ps6 follow the expansive phase and causally linked to it. So, observations of the Ps6 event in the morning or evening sectors coincided with onset in the midnight sector. Analyses of magnetic and plasma spacecraft measurements (Interball-1, Equator - S, Geotail and AMPTE/CCE projects during 1995-2000) demonstrates presence of magnetosonic component in wave pockets. Wave frequencies are less then frequencies of ULF wave events in the inner magnetosphere. These wave events also where found in the ground based magnetometers. Also due to particle acceleration (spacecraft observations show strong modulation of electron and proton fluxes) Ps6 events become apparent in riometer measurements and auroral events. CANOPUS array stations observations (magnetometers, riometers and fotometers) and INTERMAGNET magnetometers systems data was used. Due to multipoint observations it is possible to obtain spatial and temporary Ps 6 event structure and its dynamic parameters. Transversal to magnetic field size of wave pocket is about 58 RE near the magnetic equator plane. So Ps6 events may be described as the active tube along to Earth magnetic field line. It moves earthward, transverse to magnetic field with speed about 2-6 km/s. On the Earth surface it moves along the magnetic parallel. Moving velocity decreases during earthward travelling. Tracing of some Ps 6 demonstrates there direct association to onset phase. Soliton with modulation envelope model is proposed to explain the observable Ps6 behaviour.

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ASIII020 **Oral Presentation** **3416**

The Dynamics of Ion Outflow into the Magnetosphere

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A fundamental part of the magnetosphere-ionosphere response to changing solar wind conditions is the outflow of plasma from the ionosphere into the magnetosphere. Ions that begin with energies of 1 eV or less can be accelerated by a variety of mechanisms as they move upward from the topside ionosphere. The combination of convection-driven transport with accompanying acceleration caused by the curvature of the Earth's magnetic field and the cross-tail electric field can transport these ionospheric ions throughout the magnetosphere and can transform their energies from ionospheric energies to ring current energies as the particles move from region to region in the magnetosphere. In this paper we will examine the multiple acceleration and transport processes to which ionospheric ions are subjected using data from the Thermal Ion Dynamics Experiment (TIDE) on the Polar satellite. The presentation will include information on ion outflow contributions to the plasma sheet and ring current as well as to the plasmasphere and the warm plasma cloak, a population of intermediate energy ions (10's to 100's of eV) that is found in the middle magnetosphere. Using TIDE data and ion trajectory calculations, we will demonstrate mechanisms by which the ionosphere contributes to the dynamical evolutionof the magnetosphere-ionosphere system.

Keywords: ionosphere, outflow, magnetosphere

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ASIII020 **Oral Presentation** **3417**

SuperDARN Observations Of Mid-Latitude Pi-2 Pulsations

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Raymond A. Greenwald, Colin L. Waters, Kazue Takahashi, David G. Sibeck, Maichael Ruohoniemi, Joseph Baker, Robin Barnes, Kjelmar Oksavik

We report the first unambiguous Pi-2 observations made by ground based HF radars. Some of the early subauroral observations with the new SuperDARN radar at the NASA Wallops Flight Facility show clear changes in ionospheric convection in the nighttime sector on time scales of 2 minutes or less. Typically, the line-of-sight velocities observed along many of the radar viewing directions varied by as much as a few hundred meters per second about a baseline value of less than 100 m/s. We find the LOS variations to be highly correlated with ground magnetic pulsations. The availability of both ground based magnetometer data and ionospheric LOS measurements enable us to provide a completeanalysis of the wave properties. We show examples of these velocity variations and associated magnetic variations. We further present examples of concurrent magnetotail data indicating substorm processes. All these observations suggest that the subauroral ionosphere show clear impacts of magnetospheric substorms.

Keywords: substorm, pi2, pulsations

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ASIII020 **Oral Presentation** **3418**

Ion and neutral polar wind pulsing

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Ionosphere/magnetosphere coupling through mass, momentum, and energy transport has been parameterized as a flow from an entire polar cap region in terms of the number of particles per second. This number is typically on the order of 1025 particles/sec for H+, and 1025-1026 particle/sec for O+. Also, the outflow flux at high-latitudes has been shown to vary temporally by as much as four orders of magnitude. New model results obtained at Utah State University using the 3-D neutral and ion polar wind code with realistic convection and precipitation inputs for a large geomagnetic storm have been conducted. The simulation shows a pulsing of the total particle outflow on the order of hours, with large outflows occurring over spatially separated areas, principally the auroral oval. The neutral steam outflows (the neutral polar wind) are produced in charge exchange reactions between the ion polar wind and the background thermal and geocoronal neutrals. The neutral hydrogen stream particles are highly correlated to electron precipitation energy input, and the neutral oxygen stream, hydrogen ions, and oxygen ions show large upward and downward fluxes related to the amount of heating added to the auroral oval by the precipitating electrons.

Keywords: ionosphere, polar wind, micoupling

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ASIII020 **Oral Presentation** **3419**

Conditionally integrated incoherent scatter radar data and flickering aurora

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Flickering aurora is characterized by optical emissions varying in intensity with frequencies typically between 5 and 20 Hz. The horizontal scale size of flickering columns are typically 1-10 km, while the vertical extent is 10-40 km. At times the flickering appears as a whirling motion. Here we use high-speed narrow field-of-view imaging in white light to determine the intensity variation in the field aligned direction, which is also the direction of the beam of the EISCAT Svalbard Radar (ESR). Incoherent scatter radar data is noise-like, and must be integrated over multiple pulses to reduce the variance to useful levels, even for high signal to noise ratios. Usually, this means integrating over several seconds to some tens of seconds of observation, which is not very useful with respect to flickering aurora. In the experiment presented here, we have taken data at the voltage level, before any integration. By doing so, we are free to define integrations which are not necessarily contiguous in time. We have used the intensity variation of flickering aurora within the area of the radar beam to define local temporal origins, and have integrated together pulses at the same time offset from the nearest origin to investigate whether radar backscatter varies in a way which is correlated with the variation in optical emission intensity. We present the technique and preliminary results of this investigation.

Keywords: incoherent scatter radar, flickering aurora

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ASIII020 **Oral Presentation** **3420**

The Typical Auroral Substorm: A Bifurcated Oval

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Utilizing global auroral images obtained by Polar VIS Earth Camera we have analyzed the UV emissions from 116 classical auroral substorms. Average auroral emission patterns were deduced for 11 time steps of the substorm covering 20 min prior to the onset until well into the recovery phase. These average patterns were based on a three step normalization technique, one temporal and two spatial. Based on this study we can make the following conclusions. The normalization technique is highly efficient in minimizing the smearing of key features in the auroral emission pattern. We can conclude that even though the individual events may vary significantly in intensity, size, position and lifetime all have the same key emission features and can be represented by our average patterns. Thus our normalization results quantitatively validate the Akasofu assumption that key auroral features exist in the bulge-type auroral substorm. After the onset the auroral oval is clearly bifurcated consisting of two components: the oval aurora in the latitude range of the pre-onset oval, and the bulge aurora, which emerges out of the oval, expanding poleward and both east and west in MLT. Due to the pronounced difference in spatiotemporal behavior of the two auroral components we speculate that they are quasi independent, and thus the sources of electrons must also be independent.

Keywords: substorm, aurora, conductivity

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ASIII020 **Oral Presentation** **3421**

Wave acceleration of auroral electrons in the presence of quasi-static parallel electric fields

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Recent observations from the FAST satellite as well as a number of sounding rocket missions have shown two distinct modes of auroral electron acceleration: the classic inverted-V signature consisting of a beam broad in pitch angle but narrowly confined in energy, and a lower energy, field-aligned acceleration that has been attributed to kinetic Alfvn waves. Moreover, observations indicate that these two particle populations often co-exist, suggesting that Alfvnic acceleration can occur on field lines with a quasi-static potential drop. Reflected ionospheric electrons can interact with the downward propagating Alfvn producing a Fermi-like acceleration mechanism. A non-local kinetic theory including trapped and reflected electrons has been developed to model these wave-particle interactions. Results from this model of the evolution of the electron particle distributions will be presented and compared with test particle simulations.

Keywords: alfven waves, aurora, wave particle interactions

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ASIII020 **Oral Presentation** **3422**

Diurnal and multi-day variation in plasmaspheric He+ inferred from EUV images

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EUV images of the Earths plasmasphere from the IMAGE spacecraft have aided in the qualitative understanding of low energy (~1 eV) charged particle behavior in the inner magnetosphere. Observations of plasmaspheric plumes, azimuthal variations in density, and the location of the plasmapause have been useful in corroborating results of in situ spacecraft and ground-based instruments. However, quantitative photometry using EUV brightness within the plasmasphere has seldom been attempted. We observe a diurnal plasmaspheric brightness variation using successive snapshots of the plasmasphere taken by the Extreme Ultra Violet (EUV) imager on the IMAGE spacecraft. Analysis of average EUV photon counts from a sub-corotating patch of plasma over several successive images allows us to follow a flux tube and track the brightness variation across ~6 - 9 hours of local time, at an L-shell value centered at 2.5. These EUV brightness observations can be converted to He+ column densities when solar EUV flux is taken into account. Variations in this He+ column density during a single traverse across the day side, as well as at the same local time from one day to the next, can help provide insight into plasmaspheric density, the process of refilling by ionospheric plasma outflow, and the factors controlling it on diurnal and multi-day timescales.

Keywords: plasmasphere, refilling, euv

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ASIII020 **Oral Presentation** **3423**

Effects of Empirically Driven Ionospheric Outflow in Global MHD Simulations of the Magnetosphere

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In an effort to include and investigate the effects of ionospheric plasma on magnetospheric processes we have implemented ionospheric outflow in both single- and multi-fluid versions of the LFM global MHD simulation. Since we currently lack a full physics-based description of the plasma dynamics from an altitude of about 1 Re down to the topside ionosphere, we use empirically-derived causal relationships between down-going Poynting flux and ionospheric outflow flux. Two such relationships have been presented in Strangeway et al., 2005 and Zheng et al., 2005. Both have the form F = A*S**b, where F is the outflow flux, S is the downward Poynting flux, and A and b are coefficients that differ between the two studies. We find that employing the coefficients from the Strangeway et al. study yields outflowing fluences of the same order of those determined from statistical analysis of ionospheric outflow observations (e.g., Lennartsson et al., 2004). Using the coefficients from Zheng et al. produces fluences of about an order of magnitude smaller. Additionally, the spatial distribution of the outflow, and thus the ultimate destination of the outflowing ions, is different for the two sets of coefficients. Both results are critical for understanding the effects of cold and/or heavy ionospheric plasma on reconnection processes in global MHD simulations, both in the magnetotail and on the dayside magnetopause. The multi-fluid version of the simulation allows us to investigate these effects as we are able to track the ionospheric fluid as it convects through the magnetosphere.

Keywords: magnetosphere ionosphere, outflow, simulation

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ASIII020 **Poster presentation** **3424**

Local time variation of magnetic disturbances and asymmetry of the ring current during super-intense storms (DSt<-250 nT)

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Walter Gonzalez

We have studied the ring current asymmetry during super-intense (Dst <-250 nT) magnetic storms. Fifteen superstorms that have occurred during the period 1981-2004 were selected for this study. Geomagnetic indices Dst, SYM-H and ASY-H and the disturbance H-component (dH) of geomagnetic field, as recorded by low-latitude magnetic observatories, are used. We present in this work the relation between ASY-H and SYM-H indices along the magnetic storm and the local time dependence of the dH.

Keywords: geomagnetic storms, ring current, space weather

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ASIII020 **Poster presentation** **3425**

Strong geomagnetic storms and its effect on the ionosphere and the telluric currents

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With the present study we present the analysis of long-term changes of strong geomagnetic storms and consequent variations in telluric currents. The Earth currents thus originated as geomagnetic induced currents (GICs). The temporal variability of geomagnetic activity increases particularly at very high activity levels and at high latitudes with consequent stronger induced telluric currents. The aa index and the Akasofus epsilon parameter are used in the present analysis. Strong geomagnetic activity, measured by aa, present a clear long-term behavior in the amount of strong activity periods occurrence, which we describe as a Suess cycle modulated by a Gleissberg cycle. Epsilon, considered here as an indicator of the auroral electrojet intensity, presents a similar behavior, as expected, but with a lesser steep trend. We extend these results to telluric currents, which may respond almost linearly to epsilon.

Keywords: geomagnetic storms, induced currents, ionospheric currents

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ASIII020 **Poster presentation** **3426**

Center-West Argentina gas pipeline: A Study

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Electromagnetic storms in the space near the Earth may adversely affect spatial navigation, aviation, electric transmission and telecommunication networks, railways and gas and petrol pipelines. These geomagnetic disturbances have affected electric systems for about 160 years. The first effect was registered in 1840 in the telegraph and over the last years they have caused blockings of electric and communications systems. Said affected systems include all those using electric leads, either electric transmission systems as such where conduction properties are incidental, pipelines or railways. This work shows a report of telluric current on pipelines in the last 20 years and analyzes a particular case in the center-west pipeline of Argentine Republic.

Keywords: geomagnetic storms, induced currents, pipelines

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ASIII020 **Poster presentation** **3427**

Magnetic activity in the polar cap (PC index) as a precursor of magnetic substorms

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Polar-capThe PC index has been introduced to estimate the response of the polar cap magnetic field to geoeffective changes in the solar wind parameters. The unified PCN and PCS indices calculated on basis of magnetic data from stations Thule and Vostok are well consistent with one another and linearly correlate with the geoeffective interplanetary electric field (Em). The PC index responds to changes in the impacting Em with mean delay time about 20 minutes. The relations of the polar cap magnetic activity to magnetic disturbances in the auroral zone (characterized by AE and AL indices) has been examined for both isolated magnetic substorms and periodical substorms. The statistical analysis of the isolated substorms occurring on the background of the quiescent magnetic field showed that the sudden onset is preceded by increase of the PC index at the foregoing growth phase (during hour preceding the substorm onset). The PC index in summer polar cap (the summer PC) grows much faster than that in the winter polar cap and reached, by time of the sudden onset, a higher value than the winter PC index, irrespective of the disturbance intensity. After the sudden onset (during the expansion phase) the summer PC index changes little (or even decreases in cases of long substorms), contrary to the winter PC index that changes in conformity with the course of the magnetic bay. The results give evidence that the summer PC index, being mostly affected by the geoeffective interplanetary electric field, is not responding to the auroral disturbances. The periodical (sawtooth) substorms represent a good illustration of linkage between the incoming energy and the substorm intensity in cases of long impact of a geo-effective solar wind. Substorms occur if the growing PC index exceeds a value of ~ 2 mV/m during tens minutes. The substorm onsets follow the PC enhancement with a delay in the range 15 - 60 minutes, if the PC index remains less 4 mV/m. With further increase of the PC index the average delay time is shortened and can fall to zero, if the PC value exceeds 6-8 mV/m. A decrease of the PC index to a level lower than 2 mV/m is definitely followed by substorm decay. The observation that the substorm onsets followed the PC index variations, no matter whether the IMF is continuously southward or fluctuating, is indicative of an intrinsic cycle time of 2-3 hours typical of the solar wind-magnetosphere coupling. It is concluded that the PC index can be regarded as an adequate characteristic of the solar wind electromagnetic energy, transferred into the magnetosphere, the index growth being indicated the magnetic substorms onset.

Keywords: polar cap, magnetic, activity

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ASIII020 **Poster presentation** **3428**

Cluster results on auroral electric field scale sizes

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The scale sizes of intense (> 0.15 V/m, mapped to the ionosphere), high-altitude (4-7 Earth radii geocentric distance) auroral electric fields (measured by the Cluster EFW instrument) have been determined in a statistical study. Monopolar and bipolar electric fields, and converging and diverging events, are separated. The relation between the scale size, the intensity and the potential variation is investigated. The median scale sizes of these auroral electric field structures are found to be similar to the median scale sizes of the associated FACs and the density gradients (all in the range 4.4-4.8 km) but not the median proton gyroradius at these times and locations (23 km). (All values are mapped to the ionospheric altitude for reference.) However, for the monopolar events, the FAC and density gradient scale sizes are independent of the electric field scale sizes. In contrast, there is a clear proportionality between the density gradient scale size and the electric field scale sizes for the bipolar events. A proportionality between the diverging electric fields scale sizes and the scale sizes of the FACs is also found. This indicates a higher degree of local current closure for the bipolar structures compared to the monopolar structures.

Keywords: aurora, electric fields, cluster

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ASIII020 **Poster presentation** **3429**

The global geomagnetic and auroral response to the sudden expansion of the magnetosphere

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The features of the meridional and azimuth propagation of sudden geomagnetic impulses, formation of their equivalent ionospheric current systems during periods of expansion of the magnetosphere at different direction of IMF By and Bz components and different magnitude of IMF By are studied. The results of present research with results obtained earlier at studying of the positive sudden impulse (SI+) in the work [Solovyev et al., 2005] are compared. It has been found that the negative sudden impulse (SI-) as well as SI+ are propagated poleward with the velocity of 1-5 km/s. The azimuth propagation of SI- occurs similarly the propagation of SI+ to the west (east) from a noon meridian in the morning (evening) sector. Velocities of azimuth propagation have been registered mainly in two ranges V1=4-12 km/s and V2 =17-30 km/s. The analysis of the events observed at different IMF |By/Bz| (>1 or =< 1), at positive and negative IMF By shows that in general the character of the propagation of SI- vary depending on the magnitude and direction of IMF By. Same propagation character observed in SI+ events. It is suggested that in SI- events where this regularity upseted, ionospheric conductivity variations due to the energetic particle precipitation (SI- triggered aurora) have major contribution to character of azimuth propagation, than MHD waves propagation effects during field lines reconnection at great values of IMF By. In the event of SI- triggered aurora the dynamics of aurora luminosity similar to the ones observed in SI+ events. However SI- can also result in decreasing of particles precipitation intensity that in reduction of auroral luminocity region is manifested. Contribution of possible mechanisms of energetic particle acceleration during SI- event is discussed. Distributions of equivalent ionospheric currents observed during SI- events are not the mirror image of distributions of currents during SI+ as it is supposed in the works [Araki, 1994; Fujita et al., 2004]. It is assumed that at a sharp expansion of the magnetosphere unlike the compression, only the region 1 field-aligned currents are intensificated, the ionospheric conductivity is changed at latitudes >70 deg. As a result, in the high-latitude ionosphere the observed distributions of currents appear. The work is financially supported by the program of Presidium of the Russian Academy of Sciences 16, item 3, grants of the RFBR 06-05-96118, INTAS Ref. 06-1000013-8823.

Keywords: impulses, currents, particles

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ASIII020 **Poster presentation** **3430**

Electron-acoustic solitary waves in electron-ion beam plasmas

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Nonlinear electron-acoustic solitary waves (EASWs) are studied in an unmagnetized electron-ion beam plasma system consisting of cold plasma electrons, hot electron beam, cold plasma ions and hot ion beam. The analysis takes into account the dynamics of all the species. Using pseudo-potential analysis the properties of arbitrary amplitude EASWs are investigated. The amplitudes and widths of the electron acoustic solitary structures are obtained. The present study could be useful to construe the compressive and rarefactive electric field bipolar pulses associated with the BEN (broadband electrostatic noise) type emissions in the magnetospheric regions where the electron and ion beams are present.

Keywords: solitary waves, broadband electrostatic noise

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ASIII020 **Poster presentation** **3431**

Searching for ULF signatures of the Cusp: Observations from search coil magnetometers and auroral imagers in Svalbard

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Spacecraft traveling through the cusp at altitudes ranging from near the magnetopause to just above the ionosphere have consistently found the cusp to be filled with intense but irregular power in both electric and magnetic fields in the upper ULF frequency range (up to at least 4 Hz). Ground-based induction magnetometers have for many years observed Pc 1-2 (electromagnetic ion cyclotron) waves in this same frequency range at various latitudes including near the footpoint of the cusp, but it has not been possible with magnetometers alone to either confirm or deny a cusp source for any of these waves, partly because of the occurrence of horizontal ducting of these waves in the ionosphere. We report here on the first simultaneous, collocated observations of a set of induction magnetometers installed at three sites on Svalbard (Longyearbyen, Ny lesund, and Hornsund), and auroral imagers also located at the first two of these sites. Data during northern winter 2006-2007, when the cusp footpoint was in darkness, showed occasional narrowband Pc 1-2 wave events, frequent broadband noise when energetic particle precipitation occurred overhead, but the consistent absence of broadband ULF power above the noise level when only soft cusp precipitation was overhead. The intensity of narrowband Pc 1-2 wave events most often increased toward lower latitudes, consistent with wave sources on closed field lines. However, on one day when the cusp was observed to be equatorward of Longyearbyen, band-limited Pc 1-2 wave power was strongest at Ny lesund, the northernmost station. This latter observation is consistent with waves originating in the plasma mantle just poleward of the cusp, as was found in a recent study using the Polar satellite and more widely spaced ground-based ULF observations by Engebretson et al. [2005], and again suggests that the cusp proper is not the source of any narrowband Pc 1-2 wave activity that can be observed on the ground, and little if any broadband activity as well.

Keywords: cusp, ulfwaves

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ASIII020 **Poster presentation** **3432**

The spatial structure of ionospheric vorticity as measured by the SuperDARN radars

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Measurements of ionospheric plasma vorticity represent a good proxy for field-aligned currents, which are the primary physical mechanism coupling the magnetosphere to the ionosphere. Here, we present a new method for determining the ionospheric plasma vorticity from Super Dual Auroral Radar Network (SuperDARN) line-of-sight velocity data. We use these measurements to investigate the spatial structure of the ionospheric vorticity in both open and closed field line regions of the ionosphere.

Keywords: ionosphere, superdarn, vorticity

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ASIII020 **Poster presentation** **3433**

Change in Ionospheric Electric Field and Geomagnetic Field due to Solar Wind Variations at the time of SC

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The sudden increase of the dynamic pressure of the solar wind (Psw) causes a sudden increase of the geomagnetic field especially in low latitude region. It is called geomagnetic sudden commencement (SC). The disturbance field SC is divided into two component [Araki, 1977 and 1987]. DSC = DL + DP, where DL represents a step-function like increase of the H-component dominant at low latitudes. It is caused by the current circuit flowing on the magnetopause and the propagating compressional wave. DP shows the two pulse structure dominant at high latitudes due to the polar ionospheric electric field. DP = DPPI + DPMI , PI (preliminary impulse) and following MI (main impulse) are caused by the dusk-to-dawn and dawn-to-dusk electric fields respectively. These electric fields are believed to penetrate into the polar ionosphere from the magnetosphere [Tamao, 1964 ; Araki, 1994], and travel instantaneously to the low-latitude ionosphere [Kikuchi et al., 1978 ; Kikuchi and Araki, 1979]. However, the SC-associated electric fields in the low-latitude ionosphere are not yet sufficiently clarified and the effect of interplanetary magnetic field (IMF) on SC variation on the ground is not established. In order to measure ionospheric electric fields, we have constructed an FM-CW radar (HF radar) at Sasaguri, Fukuoka (geomagnetic latitude=23.2 degree, geomagnetic longitude=199.6 degree). The FM-CW radar observation started in November, 2002. By using the doppler mode of FM-CW radar, we can detect the vertical drift velocity (v) of the ionosphere and its altitude with 10 seconds sampling. The ionospheric electric field E is derived by the relational expression of E=vxB. Where the IGRF model is used to estimate magnetic field (B) at Sasaguri. From the above relation, we can estimate the ionospheric electric field in the east-west direction. So we can observe short-period phenomenon of electric fields penetrating from the magnetosphere into the low-latitude ionosphere. We analyzed 40 SC events that recorded by a magnetometer at KUJ (G.M. Lat=23.6 degree, G.M.Lon=203.2 degree) and the FM-CW radar during the period from 2002 to 2005. The magnetometer station is part of the CPMN chain [Yumoto and the CPMN Group, 2001]. At first, we compared the MI electric field with the magnetic field at the time of SC (MI). We found a positive correlation (correlation coefficient=0.70) between the MI electric and magnetic fields. We also compared the MI electric fields with changes in the Psw at the time of interplanetary shock event. There was a weak correlation (correlation coefficient=0.65) between them. On the other hand, no correlation was found between the Esw (electric field of the solar wind) and the MI lectric field. The ionospheric MI electric field seems to depend mainly on the Psw. In the next step, we analyzed 2 PI events that occurred around 14 h local time at Sasaguri. May 9, 2003 event occurred under the southward IMF condition, while the other February 18, 2003 event occurred under the northward IMF. From this comparison, we found that the PI electric field became weak under the southward IMF condition in the low-latitude region. It seems that the southward IMF reduces the intensity of the ionospheric PI electric field. As a result, preliminary reverse impulse (PRI) is not easily be detected in the dip equatorial region during the period of southward IMF.

Keywords: sc, radar, ionosphere

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ASIII020 **Poster presentation** **3434**

Parallel electric fields due to shear Alfvn Waves at 3-6RE altitude

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Robert Rankin

Observations indicate that shear Alfvn waves may be important for accelerating electrons at altitudes of 3-6RE, as well as at lower altitudes, where the auroral acceleration region is usually located. At these higher altitudes, the plasma is more likely to have similar thermal and Alfvn speeds, hence the shear Alfvn wave is not in the inertial limit, but in an intermediate regime, where approximations of the parallel electric field due to fluid theory are invalid. We investigate the parallel electric field and accompanying electron acceleration due to shear Alfvn waves in plasma conditions typical of 3-6RE altitude using a self-consistent kinetic simulation code. The results from the simulation demonstrate that in this plasma regime, electrons can easily be accelerated to energies of a few keV, even by waves with modest amplitudes. We compare the parallel electric field obtained from the simulation to that predicted by theory, and we compare the simulation results to in-situ observations to demonstrate that shear Alfvn waves can be effective accelerators of energetic electrons along an extended range of locations on auroral field lines.

Keywords: simulation, aurora, acceleration

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ASIII020 **Poster presentation** **3435**

Polar ionosphere response to changes of mutual orientation of poynting vector in near-earth space and geomagnetic moment

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Global dynamics of magnetosphere-ionosphere system is determined first of all by mechanism of energy transfer from the solar wind to magnetosphere. Direction of Poynting vector P=[ExB] shows path of propagation of electro-magnetic energy from the solar wind. Orientation of the P vector relative to geomagnetic moment vector M changes during orbital and daily motions of the Earth. We present our results of the effects of the mutual orientation changes on planetary and on high latitude geomagnetic activity (Dst, AL, AU indices) and on configurational changes of current systems in the polar ionosphere. Orientation of the P vector in GSE coordinate system is calculated on basis of spaced measurements of the IMF B and the solar wind velocity V (E=[VxB]) for the period 1963-2005. We calculated orientation of the M vector in GSE c.s. for year. We show that component Pm of P vector along M vector has clear annual and UT variation. The statistical annual variation of Pm has two peaks: in November (P is directed to the Earth at South pole and from the Earth at North pole) and in May (P has opposite direction). It is known that classical annual variation of geomagnetic activity has peaks at near equinoxes. UT variation of Pm demonstrates clear peaks at ~6 and ~18 UT. Analysis shows that precise phases of these variations are determined by pure geometric parameter connected with mean azimuth angle of the IMF spiral of Parker and annual (UT) variation of M. This annual and UT variation of Pm does not depend from sign of the IMF structure. We attract results of our studies and others to connect these findings with geomagnetic activity and current systems. The part of annual variation of Dst that doesnot depend from sign of the IMF has peaks in May and November. Annual variation of AL indices characterizing intensity of auroral westward electric jet has peaks in May and November too. Our detailed analysis shows that equivalent current systems of polar ionosphere consist of two parts: the first part depends from the IMF sign (such as DP4) and the second part doesnot depend from the IMF sign (this current system is similar to DP2 but its intensity determined by value of Pm has UT and annual variation: peaks in May and November at ~6 and ~18 UT; some authors connect it with value of the IMF By component). Thus, source of the currents in polar ionosphere is electric and magnetic energy of the solar wind that is passed on from magnetosphere to polar ionosphere by field-aligned currents.

Keywords: poynting vector, magnetosphere, ionosphere

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ASIII020 **Poster presentation** **3436**

Investigation of the temporal evolution of mid-latitude ionospheric current system by natural orthogonal component analysis

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The ionospheric and magnetospheric current systems contributed to ground magnetic field changes such as the daily variation along with all the day-to-day changes. In the last years, Xu and Kamide (JGR, 2004) implemented a technique, the Natural Orthogonal Component (NOC) analysis, able to separate and recognize the different contribution of ionospheric-magnetospheric current systems to the daily changes. This technique is aimed to decompose a temporal signal in its natural components, the empirical orthogonal functions (EOF), and their corresponding amplitudes, the principal components (PCs), once a linear superposition of effects is assumed to be valid. In this work we investigate the characteristics of the PCs associated to the daily changes of ionospheric-magnetospheric currents as observed by mid-latitude ground-based geomagnetic field measurements at "L'Aquila" (Italy). Spectral and statistical properties of the PCs are investigated and compared to those of a set of deors of the magnetospheric dynamics and solar wind changes. A discussion in terms of current systems and seasonal and long time scale variations is also provided.

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ASIII020 **Poster presentation** **3437**

Space-ground cross-phase analysis of Pc3 pulsations

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Hermann Lhr

Space-ground phase difference of magnetospheric fast mode ULF waves and ground Pc3s is considered to be one of the key parameters from which the mode of these magnetospheric waves can be determined. However, the observations and results published so far are rather controversial. Some authors established a constant 180phase difference in the L= 2-3 range, independent of wave frequency, and interpreted this observation as a possible indicator of a plasmaspheric cavity resonance mode. Others found that the observed phase delay depends on both the wave frequency and the conductivity of the ionosphere. From the linear dependence of the phase delay on the wave frequency they concluded the propagating mode and argued that the delay is introduced by the dayside ionosphere. Theoretical approaches, however, suggest that a proper interpretation of phase relations should take into account all the possible wave modes reflected in ground signals and in the wave activity in space, as well as the role of the ionosphere. Based on magnetic field measurements from the satellite CHAMP and the MM100 ground magnetometer array we map the global distribution of space-ground phase difference in the Pc3 range for the first time. Our results show that this quantity depends primarily on the longitudinal (or MLT) separation of the satellite and the ground station, but the MLT of the ground reference station also plays a role. In the light of the accumulated new knowledge we try to draw some conclusions on the possible sources of the mid-latitude Pc3s.

Keywords: magnetosphere, ulfwaves

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ASIII020 **Poster presentation** **3438**

Modeling of magnetospheric VLF response to atmospheric infrasonic waves

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Peter Bespalov, Olga Savina

We consider a model of the influence of atmospheric infrasonic waves on VLF magnetospheric whistler wave excitation. This excitation occurs as a result of by a succession of processes: a modulation of the plasma density by acoustic-gravity waves in the ionosphere, a reflection of the whistlers by ionosphere modulation, and a modification of whistler waves generation in the magnetospheric resonator. Variation of the magnetospheric resonator Q-factor has an influence on the operation of the plasma magnetospheric maser, where the active substances are radiation belts particles and the working modes are electromagnetic whistler waves. The magnetospheric resonator, which is an oscillating system with a high quality factor, can be responsible for an excitation of self-oscillations. These self-oscillations are frequently characterized by alternating stages of accumulation and precipitation of energetic particles into the ionosphere during a pulse of whistlers emissions. Numerical and analytical investigations of the response of self-oscillations to harmonic oscillations of the whistler reflection coefficient shows that even a small modulation rate can significantly changes the magnetospheric VLF emissions. Our results can explain the causes of the modulation of energetic electron fluxes and whistler wave intensity with a time scale from 10 to 150 sec in the dayside magnetosphere. Such quasi-periodic VLF emissions are often observed in the sub-auroral and auroral magnetosphere and have a noticeable effect on the formation of the space weather phenomena.

Keywords: ionosphere, acoustic, whistler

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ASIII020 **Poster presentation** **3439**

AKR generation characters at the polar border of auroral region

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Mogilevsky M.M., Moiseenko I., Sauvaud J. A., Hanasz J.

Instantaneously measurements of low and high energetic particles, ULF and HF emissions on Interball-2 satellite are analyzed. In case of the satellite has located near polar border of auroral oval and when this border has moved to the pole relatively the satellite, following characteristic features were observed: ULF emissions and perpendicular heated low energy ions by these waves; Generation of an electromagnetic emission around a local electron gyrofrequency. Several mechanisms of high-frequency wave generations and probability of waveguide mode detection are discussed.

Keywords: akr,,

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ASIII020 **Poster presentation** **3440**

The Meridional Current System During Substorm Expansion Phase

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Jun Liang

Current closure in the ionosphere influences the course of auroral substorm. A meridianal current system (MCS) has been identified during substorm expansive phase (EP). We show that the emergence of MCS is due to an intensified Harang disconuity and its effect on the mid magnetotail, in terms of flow acceleration in thedawnward direction. We present ground-based and in-situ evidence of this acceleration, and show theoretically that the inertial current associated with the flow provides the downward field-aligned current completing the MCS.Quantitative calculationsare performed to reproduce many observed features of the MCS. We further discuss how the present work relates to the large-scale FAC system and the interactions among its various components, with a particular emphasis on the MCS contribution to the overall substorm current closure.

Keywords: field aligned, currents, substorms

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ASIII020 **Poster presentation** **3441**

The relationship between geomagnetic auroral disturbances and By IMF during geomagnetic storms

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Anna Koshlyak

A study on the relationship between auroral disturbance and geomagnetic storms, depending on the sign By IMF component. In this work the intensity of the auroral perturbation estimated by AE-index. Compared geomagnetic storms with equal Dst-index but developing in different period sign By IMF. It is show that the intensity of auroral disturbances in AE-index above in a positive By IMF, and lower than in the negative. The reason is a longitudinal currents of which depends on the sign By IMF.

Keywords: geomagnetic storm, auroral current

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ASIII021 **3442 - 3487**

Symposium
Geomagnetic storms: toward a coupled system level understanding (Divisions III and II)

Convener : Prof. Tuija Pulkkinen

Storms and other geomagnetic disturbances are manifestations of enhanced solar wind magnetosphere coupling, whose effects can be detected as configurational changes and high temporal variability. Solar wind disturbances and southward-oriented interplanetary magnetic field enhance the ring current and radiation belts, distort and disturb the electromagnetic fields, and strongly increase the ionosphere magnetosphere interaction. During these events the system displays dynamics intrinsic to its coupled interactions that are not evident during normal moderately disturbed conditions. This session concentrates on understanding the system storm-time dynamics incorporating the coupled interactions between the solar wind, magnetopause, polar regions, magnetotail and plasma sheet and inner magnetosphere. Papers addressing these questions using ground-based and space-borne observations, modeling and simulation techniques, or theoretical analysis are all welcome.

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ASIII021 **Oral Presentation** **3442**

Influence of the magnetopause location, ring current, plasmasphere, and plasmaspheric plumes on the evolution of the radiation belt fluxes during geomagnetic storms.

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Geomagnetic storms may produce a net increase or decrease in the relativistic electrons in the radiation belts. Various loss and source processes which operate inside and outside plasmasphere and in the regions of plumes are discussed. In particular inside plasmaspere hiss waves will scatter particle in pitch angel. Outside plasmasphere ring current electrons will excite chorus waves which will scatter radiation belt electrons in both energy and pitch-angle while EMIC waves exited by the anisotropy of ring current ions in the regions of plumes will produce pure pitch-angle scattering and consequently loss of electrons. We will also discuss the combined effect of losses to magnetopause and outward radial diffusion. The discussed loss and source mechanisms will be illustrated by the simulations with 1D 2D and 3D diffusive code simulations and compared to observations on CRRES, HEO and SAMPEX satellites.

Keywords: radiationbelt, loss, source

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ASIII021 **Oral Presentation** **3443**

The study of the Solar-Geophysical events and effects on the meteorological parametars changes

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geomagnitic opservatori geomagnetic disturbances IAGA

Cop Rudi, Palangio Paolo, Lazovic Caslav

The results of different solar and climatological researches, show connection between solar geomagnetic activity changes (SGMA), electromagnetic environmental field changes (EEMF) and meteorological parameters (MP) changes. Changes of SGMA, EEMF and MP could be seasonal, yearly or long periodic, cyclic changes. In today researching, Earth atmosphere is observed as complex and dynamic system. Processes in different levels of atmosphere are in interaction. Changes of the intensity solar emission, changes of indices of the solar activity, changes of the Sun's wind speed, induce changes of the atmospherice parameters. Satellite researches show that during registration of the class intensive magnetic storms, on sensors are registered changes of the density and temperature of upper atmosphere levels. In this work will be shown and analyzed geophysical processes which determinate the SGMA disturbances. Those are occurrences of intensive solar flares (Sun's hromospheric eruptions), solar and magnetic storms. In period 1986-2004, during 22nd and 23th Sun's cycle, class of Big Magnetic Storms is registered (about ten storms). In first phase of analyze are observed regular daily geomagnetic field variations in month when is registered geomagnetic disturbance. In next step of the analyze, in each of mentioned Big Magnetic Storm, are observed groups of apperiodical/irregular geomagnetic field variations. That is shown by groups Dst and Di geomagnetic field variations. Analyze of structure geomagnetic field variations is done on several European observatories of the middle geomagnetic latitude. For months and days when the intensive solar and magnetic storms are registered, changes of the meteorological parameters will be analyzed. We will present distribution of hourly mean values of air temperature for magnetic quite days (Q-days) and for magnetic disturbed days (D-days), in months when the Big Magnetic Storms are registered. Assignment of hours values of the air temperature and the number sunshine interval before, during and after the SGMA disturbance will be observed. The results of analyzes of the SGMA indices changes and meteorological parameters, will be applied in researching process of meteotropical weather situation arising. The way how the SGMA indices changes are induced in the structure of the meteotropical weather situation. The meteotropical situation has the influences on dynamic and structure of changes in the biosphere. Objects in biosphere (live/unlive matter, flora, fauna, people,...),

Keywords: magnetic storms, geomagnetic field variations, solar activity

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ASIII021 **Oral Presentation** **3444**

Effects of the geomagnetic storms in the lower ionosphere: what can we learn from ground based observations?

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Ludmila Makarova

It was established recently that the geomagnetic storms could be divided in several distinctive groups depending on the dynamics of energetic (Ee > 500 keV) electron population during the storms. Both external (interplanetary) and internal (magnetospheric) factors could influence processes of acceleration and loss of energetic electrons in the near-Earth space. It is not clear which of these factors is dominant and how energetic electron population in the magnetosphere is connected with dynamics of geomagnetic activity. Since the bulk of existing conclusions on the subject are derived from satellite observations it is worthy to analyze the data of corresponding ground-based observations. This paper contains analysis of several geomagnetic storms of different intensity and duration, based on the data of ground-based geomagnetic and ionospheric (riometer and VLF phase measurements) observations. Using these data we suggested an original classification of the geomagnetic storms based on variations of traditional indices of geomagnetic activity, which turned out to be similar with classification of the storms based on dynamics of the relativistic electron population [Iles et al., 2002]. We proposed also the original expressions for determination of the boundaries of relativistic electron precipitation zones derived from the data of groundbased observations as well as of satellite measurements. A special attention was given to analysis of the geomagnetic storms where simultaneous precipitation of solar protons and relativistic electrons was observed at wide range of invariant latitudes. It seems that that the grouping the geomagnetic storms in the CME and CIR types does not take into account a real relation between simultaneous appearance of the solar protons and energetic electrons during geomagnetic storms.

Keywords: geomagneticstorms, ground basedobservations, lowerionosphere

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ASIII021 **Oral Presentation** **3445**

Dynamics of the plasmasphere during geomagnetic storms and substorms

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The dynamics of the plasmasphere during periods of enhanced geomagnetic activity has been studied with observations of IMAGE (EUV), CLUSTER (WHISPER) and the results of dynamical simulations. During geomagnetic storms and substorms, a sharp plasmapause is created closer to the Earth in the post-midnight sector and a plume develops in the afternoon MLT sector. Dynamical simulations have been developed at IASB-BIRA to show the deformations of the plasmasphere during geomagnetic storms and other variations in the level of the geomagnetic activity. The influence of the electric field model and the mechanism of plasmapause formation on the position of the plasmapause will be illustrated. The results of the three-dimensional kinetic model of the plasmasphere will be presented, as well as some recent works concerning the interactions of the plasmasphere with aurora, ring current, radiation belts and subauroral ionosphere.

Keywords: plasmasphere, substorm, plasmapause

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ASIII021 **Oral Presentation** **3446**

Modeling of the Sawtooth profile geosynchronous injections using coupled MHD and The FOK Ring current models

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Space Weather Laboratory NASA Goddard Space Flight Center IAGA

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During prolonged intervals of southward IMF Bz the magnetosphere often enters a state in which quasi-periodic, large-amplitude, "sawtooth" profile oscillations of energetic particle fluxes are observed at the geosynchronous orbit. We use the global MHD code BATSRUS to drive the Fok Ring Current Model. Introducing of kinetic corrections to the MHD code in the magnetotail region leads to fast reconnection rates observed in kinetic simulations and quasi-periodic loading-unloading cycles in the magnetotail during a long period of steady southward IMF Bz. Running of FRC model in this case correspondingly leads to quasi-periodic oscillations of geosynchronous energetic particle fluxes, similar to "sawtooth" profile oscillations. We compare these results with the results of the FRC model driven by the BATSRUS code for periodically flipping IMF Bz component, without kinetic corrections. The modeling of two different real events, with stormy and quiet solar wind conditions, demonstrates the importance of kinetic corrections.

Keywords: ring current, magnetosphere, modeling

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Studing the superstorm of may 15, 2005: "main" substorm, dynamics of the westward electrojet and outer radiation belt

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We use the data on 0.17 – 8 MeV electrons from the satellite Meteor-3M (circular orbit at ~1000 km altitude), the data from GOES-10, LANL-84, ACE and from geomagnetic stations. As seen from the Meteor data, the main phase of the superstorm of May 15, 2005, which lasted for about 2 hours only, made the outer radiation belt almost to vanish, and the belt's nightside boundary occurred at L~3. During those 2 hours, geomagnetic dynamics has been dominated by a sole substorm, the "main" substorm. Signature of that substorm given in the records of Canadian geomagnetic observatories shows the westward electrojet made an excursion to the same L~3. At geosynchronous orbit, 2 MeV electrons did not appear for almost a day of early recovery phase while the intensity of lower-energy electrons of 0.3-1.5 MeV showed gradual increase. A new belt of relativistic electrons has been formed during a substorm on May 16, at about 06UT. A peak of the belt located at L~4, and Dst at that time was about -120 nT. All the studied effects confirm the earlier established relationship |Dst|max=2.75 * 10^4/Lmax^4, where Lmax is an L-position of either a peak of the storm-injected relativistic electron belt, or the trapped radiation boundary, or the westward electrojet center. Possible mechanisms of relativistic electron acceleration are discussed.

Keywords: relativistic electrons, substorm, westward electrojet

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Trapping of 1-5 mev solar protons into the inner magnetosphere during magnetic storms

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Energetic protons measurements by low altitude polar orbiter Coronas-F allow to identify special type of the intensity enhancements associated with direct trapping of the 1-5 MeV protons to the inner radiation belt during magnetic storms. Fast retreat of the solar proton penetration boundary during the beginning of the recovery phase was allows a low energy proton transition from the quasitrapping to the adiabatic magnetic drift orbits. As a result solar protons and alpha particles became trapped in the inner magnetosphere. Such new solar ion belt (or addition to the ordinary proton belt) remain visible several tens of days. During four year of the Coronas-F operation 6 cases of the solar proton trapping have been identified and analyzed.

Keywords: solar cosmic rays, radiation belt, trapping

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ASIII021 **Oral Presentation** **3449**

Stormtime electron phase space density radial profiles and their dependence on M and K

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The Stormtime transport and acceleration of electrons in the inner magnetosphere is and important and timely topic in Geospace science. The radial gradient of the phase space density (PSD) at constant first and second invariants (M and K) provides important clues to the processes involved. We examine detailed energetic electron angular and spectral data combined with the magnetic field from SCATHA and magnetic field models to obtain the PSD radial profile evolution through a magnetic storm. We examine the pre storm PSD radial profiles and compare the changes that occur throughout the storm recovery period. SCATHA provides electron fluxes in the M range 200 - 2500 MeV/G and K range 0.06 - 0.65 Re √G over an L* range of 5.2 - 7.3 Re. L* and K are computed using the TY2001 storm model and the Olson-Pfitzer model. We compare results from the dayside magnetosphere, where the models well represent the observed field, to those taken on the night side, where the field models do not match field observations as well. The PSD radial profiles show a range of features from peaked in L* at small K and M even during the pre storm period to relatively flat for much of K and L* late in the post storm recovery. During the electron PSD enhancement period, 6-10 May 1986, the PSD radial profiles ranged from those with positive radial gradients to those that had peaks or negative radial gradients with the differences strongly dependent on the values of M and K. There were significant differences in the radial profiles for small and intermediate K values at constant M with the profiles at small K 0.06 being much flatter than those for K > 0.2 during the early recovery period. For example, the PSD profiles were flat or negative for M > 1000 MeV/G and K=0.06 Re √G, while they are peaked near L*=5.75 for K > 0.2. After the post storm PSD's maximized, during the late recovery phase, the radial profiles were relatively flat at small K or had negative slopes for K > 0.2.This emphasizes the importance of being able to measure the near equatorial pitch angle distributions so as to obtain the correct view of the radial profile structure of PSD. The results will be discussed in terms of what they imply for the electron transport and acceleration processes.

Keywords: magnetic storms, electron transport, acceleration

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ASIII021 **Oral Presentation** **3450**

Ring Current Asymmetry During Magnetic Storm on 6-14 November 2004

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Magnetospheric magnetic field variations produced by symmetrical and asymmetrical parts of the ring current were analyzed during magnetic storm occurred on 6-14 November 2004 with peak Dst= -373nT. The magnetic field of the large-scale magnetospheric currents was simulated by paraboloid model of the Earth's magnetosphere. To study the ring current asymmetry the model of the magnetic field of partial ring current has been developed. Partial ring current was represented as a current circuit consisting from equatorial westward current, field-aligned currents and eastward closure current on the ionospheric surface. The magnetic field of the partial ring current was calculated using Biot-Savart low. We used the ASYM-H index to estimate the total current flowing in this circuit. The symmetrical ring current intensity was determined from Burton equation which describes ring current development as a result of injection and decay processes. The injection amplitude was determined from the best fit between Dst derived from observations and from magnetic field simulation. It was obtained, that total partial ring current is about 10 MA during storm maximum. Its contribution to Dst on the storm main phase is about -100 nT, while the symmetrical ring current effect is about -250 nT. The partial ring current demonstrates fast development and sharp decay up to pre-storm level on the time-scale about of 10 hours.

Keywords: magnetic storm, ring current, dst

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ASIII021 **Oral Presentation** **3451**

Radiation belt acceleration and loss during the Halloween storms of 2003

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Using a wide array of data sets from the Heliophysics Great Observatory (HGO) spacecraft, from ground-based facilities, and from operational satellites, we have studied the highly disturbed solar, solar wind, and geomagnetic conditions in late October and early November 2003. The combination of coronal mass ejections, solar flares, and high-speed solar wind streams during this interval led to a powerful sequence of solar wind drivers of magnetospheric processes at the Earth. The result of the combined solar wind disturbances was to produce deep, powerful, and long-lasting enhancements of the highly relativistic electron population throughout the outer terrestrial radiation zone and slot region. There was evidence that many space weather-related spacecraft anomalies occurred during this active interval. We have collected and organized large sets of data and images for this so-called Halloween Storm interval. The kinds of disturbances witnessed during this remarkable interval are far beyond the types of events that commonly occur during the solar maximum period. It is important to determine how well our present models can address such extreme events. We present quantitative analyses of the acceleration and loss time scales for these storm events.

Keywords: particleacceleration, geomagneticstorms, radiationbelts

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ASIII021 **Oral Presentation** **3452**

Quantitative modeling of the ring current using ENA data assimilation

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Most of ring current simulation models requires various assumptions for input parameters due to lack of observations, and those untested assumptions may cause inaccuracies in the simulation outputs. Data assimilation is a framework for improving the realism of a simulation model so as to be consistent with observations, and it allows us to estimate the input parameters for a model on the basis of observations. We have developed a data assimilation scheme which incorporates the ENA data from the IMAGE satellite into the Comprehensive Ring Current Model (CRCM) by Fok et al. (2001). In this scheme, the electric potential distribution, plasmasheet ion density, and plasmasheet ion temperature are assumed to be unknown, and they are estimated through the data assimilation process. The trend of those temporal variations are assumed to be linear to time and updated every hour of simulation time. On the basis of the estimates of those parameters, the ring current ion distribution in the inner-magnetosphere is consequently estimated. We applied the present scheme to the magnetic storm on August 12, 2000 and October 29, 2000, in which the original CRCM with empirical input parameters overestimated the ENA flux observed by IMAGE. The result of the data assimilation suggests that the empirical model overestimated ion density at the outer boundary of the simulation domain while the temporal variation of electric field is likely to be important to explain the variation of ENA emission. The possible implications of the result are also discussed.

Keywords: ring current, magnetic storm, data assimilation

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ASIII021 **Oral Presentation** **3453**

Variation of Field-Aligned Current at Plasma Sheet Boundary Layers With AE Index During Storm Time: Cluster Observation

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The magnetic field data from the FGM instruments on board the four Cluster spacecraft were used to study Field Aligned Current (FAC) at the Plasma Sheet Boundary Layers (PSBL) with the so called curlometer technique. We analyzed the date obtained in 2001 in the magnetotail and only two cases were found in the storm time. One (August 17, 2001) occurred from sudden commencement to main phase, and the other (October 1, 2001) lay in the main phase and recovery phase. The relationship between the FAC density and the AE index was studied and the results are shown as follows. (1) In the sudden commencement and the main phase the density of the FAC increases obviously, in the recovery phase the density of the FAC increases slightly. (2) From the sudden commencement to the initial stage of the main phase the FAC increases with decreasing AE index and decreases with increasing AE index. From the late stage of the main phase to initial stage of the recovery phase, the FAC increases with increasing AE index and decreases with decreasing AE index. In the late stage of the recovery phase the disturbance of the FAC is not so violent, so that the FAC varying with the AE index is not very obvious.

Keywords: ionosphere, magnetosphere, field aligne currents

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ASIII021 **Oral Presentation** **3454**

Role of different spatial and temporal scale variations of electromagnetic fields in the evolution of energetic particle populations in the near-Earth's magnetosphere during storms

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Understanding the time-varying electromagnetic field configuration and the consequent charged particle dynamics in the Earth's space environment is fundamentally important both for scientific and space weather purposes. We have developed a time-evolving model for the inner magnetosphere magnetic field. Based on available in-situ observations of the magnetospheric magnetic field, the model gives a global representation of the magnetic field evolution during specified time periods. The main advantage of this event-oriented model is its ability to reproduce both the larger-scale and smaller-scale variations of the magnetic field during substorms and storms. We have incorporated this model into our particle tracing procedure, in which we trace particles with arbitrary pitch angles numerically in the drift approximation. From the other hand, we represent substorm-associated electromagnetic fields by adding electromagnetic pulses. There electric field is given by Gaussian pulse with azimuthal field component propagating inward with a velocity dependent on radial distance. The magnetic field from this pulse is calculated by Faraday's law. We model particle inward motion and energization by a series of electric field pulses representing substorm activations during storm events. We model two storms on October 21-23, 2001 and April 18, 2002, with characteristic saw-tooth activations observed in particle fluxes at geostationary orbit and magnetic field variations. We study the role of small-scale variations of the electromagnetic field in the evolution of energetic particle populations in the near-Earth's magnetosphere.

Keywords: magnetosphere, storms, fields

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ASIII021 **Oral Presentation** **3455**

Comparative study of Geomagnetic Sudden Commencement (SC) between Oersted and ground observations at different local times

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Oersted is a low-altitude (638-849 km) polar-orbiting satellite. Using vector magnetic field measurements obtained from Oersted, we identified more than 20 geomagnetic sudden commencement (SC) events on both dayside (0600-1800MLT) and nightside (1800-0600MLT). The unique properties reflected by these events have never been reported before. The SCs observed by Oersted in the B// (compressional) component on the nightside had the nearly same waveforms as those observed on the ground in the H (northward) component. We suggest that the SCs observed by Oersted on the nightside were dominantly caused by the enhanced magnetopause currents, which were transmitted by the compressional hydromagnetic waves, and the effects of the ionospheric current (IC) were negligible on the nightside. The SC waveforms observed by Oersted on the dayside were apparently different from those observed on the ground. Near the dayside dip equator (DDE), corresponding to preliminary reverse impulses (PRIs) observed in the ground H component, Oersted always observed positive impulses in the B// component, which suggest that the PRIs at the DDE are generated by westward ICs. On the dayside, corresponding to positive main impulses (MIs) of SCs observed in the ground H component, the Oersted B// component always presented clear decreases, which implies that an eastward IC was excited after the PRI. The generation mechanism for the westward and eastward ICs are discussed according to previously proposed models. On the dayside, we suggest that the waveforms observed both on the ground and at Oersted during the time period of PRI and MI were superposition of the incident compressional waves and the disturbance fields caused by the ICs. The features observed by Oersted just above the ionosphere are significant complementary to our empirical knowledge for SCs.

Keywords: dayside dip equator sc, pri, oersted

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ASIII021 **Oral Presentation** **3456**

Solar wind conditions associated with geomagnetic storms with Dst<-30nT

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The question What is geomagnetic storm? is debated by many investigators, and numerous new results have been obtained during last years. Despite this, our growing knowledge has not yet given us high quality magnetic storm prediction. An important obstacle on the way to successful development of geomagnetic storm prognosis techniques has been a focus on detecting the approach to the Earth of remarkable, but rare, geoeffective (CME and CIR) structures, and the scientific communitys academic interest to in the investigation of conditions in the solar wind, leading to severe magnetic storms only. Meanwhile the number of intense magnetic storms with Dst<-100nT is about 10% of the total. Thus, it is important to know: which solar wind structures are mainly geoeffective for all magnetic storms (not for severe storms only) and which typical conditions in the solar wind precede magnetic storms? Our statistical investigations for geomagnetic storms (Dst <-30nT) with SSC for 40 years and for storms both with SSC and without SSC for 25 years show that solar wind behavior before and after the onsets of all magnetic storms is different from the well-known behavior of the solar wind before and after severe magnetic storms. Most geomagnetic storms are not associated with high-speed streams. Statistically confirmed growth of solar wind density, both module of interplanetary magnetic filed and its turbulence level increase, electric field growth in comparison with the statistical average of solar wind conditions are observed from 2 hours up to 4 days relative to storm onsets. Features of solar wind parameters behavior before and after magnetic storm onset for different types of geoeffective streams and possible mechanisms of solar wind geoeffectiveness are discussed.

Keywords: solar wind deoeffectiveness, geomagnetic storm

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ASIII021 **Oral Presentation** **3457**

Improved dynamic geomagnetic rigidity cutoff modeling: testing predictive accuracy

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In the polar atmosphere, significant chemical and ionization changes occur during solar proton events (SPE). The access of solar protons to this region is limited by the dynamically changing geomagnetic field. Here we use riometer absorption observations to investigate the accuracy of a model to predict Kp-dependent geomagnetic rigidity cutoffs, and hence the changing proton fluxes. The imaging riometer at Halley, Antarctica is ideally situated for such a study, as the rigidity cutoff sweeps back and forth across the instrument's field of view, providing a severe test of the rigidity cutoff model. Using observations from this riometer during five solar proton events, we confirme the basic accuracy of this rigidity model. However, we find that the model can be improved by setting a lower Kp limit (i.e., Kp=5 instead of 6) at which the rigidity modeling saturates. We also find that for L>4.5 the apparent L-shell of the beam moves equatorwards. In addition, the Sodankyl Ion and Neutral Chemistry model is used to determine an empirical relationship between integral proton precipitation fluxes and nighttime ionosphere riometer absorption, in order to allow consideration of winter time SPEs. We find that during the nighttime the proton flux energy threshold is lowered to include protons with energies of >5 MeV in comparison with >10 MeV for the daytime empirical relationships.

Keywords: particle precipitation, geomagnetic storms, geomagnetic rigidity

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ASIII021 **Oral Presentation** **3458**

Factors Controlling the Mode of Magnetospheric Response to the Solar Wind

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There are a variety of different types of geomagnetic response to the solar wind. These include poleward boundary intensifications (PBI), pseudo breakups (PB), isolated substorms, substorm intensifications, steady magnetospheric convection (SMC), quasi-periodic substorm sequences (sawtooth events), and magnetic storms. The particular mode at any time appears to depend on the north-south direction of the IMF, its magnitude, and its waveform. Substorms occur when the IMF oscillates north and south with about 1-3 hour time constant. SMC occur when the IMF is moderate but steadily southward. Substorm sequences develop when the driver is stronger than during SMC but still steady. PBI are apparently caused by bursts of reconnection at a distant x-line. PB appear to be the result of a new near-Earth neutral line that does not develop into a full substorm. Magnetic storms result whenever the IMF is strongly southward for long intervals. A few magnetic storms appear to develop without substorms during the main phase suggesting that SMC may be responsible for ring current injection in these cases. In this paper we will contrast conditions in the solar wind related to these different response modes and show examples of transitions from one mode to another.

Keywords: magnetic storm, coupling, solar wind

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ASIII021 **Oral Presentation** **3459**

Dynamics and mechanisms of the ring current during storm and substorms

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We present our latest findings about the mechanisms for ring current intensification and its dynamics during geomagnetic storms. We use data from the IMAGE/HENA instrument and the RAPID and CODIF ion spectrometers on board the Cluster satellites. Various supporting data-model comparisons allow us to draw conclusions about the source and energization mechanisms of the storm-time ring current. We summarize by reviewing the role of the ring current in radiation belt dynamics, and in magnetosphere-ionosphere-thermosphere coupling. A geomagnetic storm is historically referred to as the intensification of the ring current. The cause of the intensification is enhanced magnetospheric convection and substorms. Convection is enhanced through day side reconnection during southward IMF, which transport plasma from the lobes, to the plasma sheet and into the ring current region where it is energized by betatron acceleration. Substorms energize plasma further through the rapid dipolarization reconfiguration of the magnetic field due to a disruption of the tail current. Substorms energize in particular O+ ions that flow out from the polar ionospheres during enhanced solar wind dynamics pressure and/or southward IMF. During the course of the storm ionospheric O+ ions are transported to the plasma sheet mainly through centrifugal acceleration where they achieve an energy of a keV or so. At the substorm dipolarization the O+ ions are energized non-adiabatically and can reach several 100s keV, whereas the protons behave more adiabatically and experience a much more gradual energization.The HENA instrument on board IMAGE images the hydrogen and oxygen ring current in the ~10-200 keV (H) and ~50-300 keV (O) range. HENA has provided global images of the ring current since May 2000 until Dec 2005. A constrained linear inversion technique is used to extract the ion distribution in the ring current, which is validated by in-situ satellite observations. Cluster carries the RAPID instrument which provides mass resolved energy spectra in the 20-400 keV for electrons, 40-1500 keV (4000 keV)for hydrogen, and 10 keV/nuc - 1500 keV (4000 keV) for heavier ions. The CIS/CODIF instrument on board Cluster resolves H+, He+ and O+ ions in the 15 eV - 39 keV range.

Keywords: ring current, magnetosphere, storm

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ASIII021 **Oral Presentation** **3460**

Full 3D MHD-Test Particle Simulations of Prompt Relativistic Electron Injections

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The dynamic variability of outer zone electrons is tied to distinct types of heliospheric structure which vary with the solar cycle. The largest fluxes occur during the declining phase from solar maximum, when high speed streams and co-rotating interaction regions dominate the inner heliosphere, leading to recurrent storms tied to solar rotation, while the most intense events are typically driven by high speed CMEs which prevail around solar maximum. An extreme example of impulsive, drift time scale acceleration of outer zone electrons into L=2.5 occurred on 24 March, 1991. The magnetopause was compressed inside the orbit of geosynchronous spacecraft, producing new electron and proton radiation belts with energies > 13 MeV in the normally depleted slot region. Radial transport and energization of electrons occurred on a particle drift time scale of minutes due to the magnetosonic impulse with induction electric field launched by rapid magnetopause compression. The electron (and proton) belts produced inside geosynchronous orbit on the time scale of interplanetary shock passage persisted for years, as observed at > 10 MeV by the low altitude SAMPEX satellite in polar orbit, launched in 1992. Five other similar events have been identified in SAMPEX PET and HEO measurements: 21 February 1994, 29 Octorber 2003, 7 November 2004, and 21 January 2005, while a triplet of storms 23 28 July also produced a > 10 MeV trapped population at L = 3, with geosynchronous fluxes at > 2 MeV the largest in two solar cycles. Full-Lorentz test particle simulations have been executed using MHD fields calculated with the Lyon-Fedder-Mobarry code, driven by upstream solar wind parameters measured by IMP 8, Wind and ACE, depending on availability. Unlike March 1991, solar wind measurements were available for the 21 February 1994 event, and continuously since the launch of Wind in 1994. Pitch angle results, available for the first time with 3D test particle simulations in MHD fields, explain the delayed appearance at SAMPEX altitude (2 months) for drift time scale injection events, strongly peaked at 90 degrees1. Results for 21 February 1994 and 24 March 1991 injections will be compared in 2D, while the 29 October 2003 and 21 January 2005 events will be examined in 3D, along with the remaining two events. Calculations are performed using the coupled magnetosphere-ionosphere MHD code developed by the Center for Integrated Space Weather Modeling. 1Looper M. D., J. B. Blake, R. A. Mewaldt, 2005, Response of the inner radiation belt to the violent Sun-Earth connection events of OctoberNovember 2003, Geophys. Res. Lett., 32, L03S06, doi:10.1029/2004GL021502.

Keywords: radbelt, electron, injections

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ASIII021 **Oral Presentation** **3461**

Ring current activity during two-step development of geomagnetic storms

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Simulation of Dst index on the basis of the solar wind energy input to the ring current and the adjustment for the solar wind dynamic pressure with the exponential decay rate of the ring current has more than thirty year-old history (Burton-McPherron-Russel). The key elements of the model were reanalyzed in numerous works and a lot of Dst-index calculations were carried out. The differences between the calculated and observed Dst values in these simulations may be accounted to all key elements of the models. In this study the ring current activity is analyzed during two-step development storms to take into account variations of elements of the models as the rate energy input and decay for simulation of Dst index. For this purpose we continued studying the solar wind parameters during the two last solar cycles. We looked for the acceptable two-step geomagnetic storms and intervals for calculation of the solar wind energy input rate function to the ring current and decay. The values of rate change of the ring current on the selected intervals of the main phases of the two-step magnetic storms were calculated and compared with the Ey-component of the solar wind electric field. The solar wind OMNI data were used. It should be noted that the last solar cycle allow us to find the acceptable intervals for the wide range of the solar wind electric field up to 30 mV/m. These calculations show us that the relationship between rate change of the ring current and Ey-component of the solar wind remains linearly proportional for great Ey values during the first and second step of compound type storms. Characteristic times of the ring current are different during the first and second step of compound storms, which occasionally results in complex ion composition of the ring current. Calculations of the two-step different intensity Dst variations on the basis obtained results have carried out.

Keywords: ring current, dst index, solar wind

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ASIII021 **Oral Presentation** **3462**

Are the Dst Stations Sufficient for Describing Storm-Time Enhancements

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It has been a consensus of the space science community that with its specific data processing and derivation procedure, what the Dst index measures are not just the storm time variations of the symmetric ring current and actually it reflects the global current enhancements during geomagnetic storms, in which significant local-time (LT) dependent components exist. In this work, by using a newly developed Wavelet-based Index of Storm Activities (WISA), we quantitatively assess whether the Dst stations are sufficient for describing the storm-time enhancements and whether there is a specific station distribution based on the existing stations that is optimal for such a purpose. Our results show that during quiet times, the H component variations at low-latitudes are largely symmetric and the Dst with four conventional stations is sufficient for monitoring the quiet-time magnetic variations. During storm times, there are significant LT-dependent current enhancements in the main phases and the early recovery phases and the present Dst stations, which have a sparse spatial distribution in longitudinal direction, are not sufficient for describing the storm-time enhancements and the Dst index normally underestimates these variations. To better represent the storm-time enhancements, our results suggest that a set of 8 specific low-latitude stations would be optimal and further increasing stations in the longitudinal direction actually reduces the effects of the enhanced LT-dependent currents in the index. This optimal number may indicate that the smallest longitudinal spatial scale of the major enhanced LT-dependent currents during storms could be about 3 LT hours.

Keywords: geomagnetic storms, dst index, storm time disturbances

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ASIII021 **Oral Presentation** **3463**

Ion Refilling Rates for L = 2.3 3.8 Flux Tubes

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Measurements of the eigenfrequency of geomagnetic field lines can provide information on the plasma mass density near the equatorial plane of the magnetosphere. Data from an extended meridional array of ground magnetometers therefore allows the radial density distribution, and its temporal variation, to be remotely monitored. Using cross-phase analysis of ground magnetometer array data, we determined the equatorial mass density during a moderate geomagnetic storm that commenced on 9 March 2004 following several days of magnetically quiet conditions. On 10 March, at the beginning of the storm recovery phase (Kp = 6+), the field line eigenfrequency over L = 2.34 3.83 was unusually high. This corresponds to very low mass densities, indicating that the plasmapause moved Earthward and these flux tubes were depleted. Over 10-13 March the eigenfrequency at these L values progressively decreased, indicating refilling of the flux tube to pre-storm levels, superimposed upon diurnal variations. By comparing density measurements we have determined the ion refilling rates and fluxes at the 1000 km level for the L = 2.34, 2.63, 3.26, and 3.83 flux tubes. The upward ion fluxes decreased with increasing L-value, being 3.9x108 amu/cc/sec at L=2.34 and 1.49x108 amu/cc/sec at L=3.83, respectively. These are in excellent agreement with daytime upward electron fluxes calculated by previous authors, and the L-value dependence can be explained by solar zenith angle control of ion production rates.

Keywords: plasmasphere depletion, plasmasphere refilling, magnetic storm

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ASIII021 **Oral Presentation** **3464**

Quasi-periodic precipitations of energetic particles and the geomagnetic pulsations of Ps6 type

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The long-period oscillations of the magnetic field and the dynamics of aurora in the morning sector during the recovery phase of magnetic superstorm of November 7-8, 2004 have been studied by data of the magnetic and riometer stations of 190-210 MM. The intense morning pulsations of Ps6 type were registered on November 8 during the substorm triggered by the excursion of IMF Bz to the north. In this event, in contrast to the classical Ps6, the amplitude of H and Z components of observed pulsations exceeded the D-component amplitude by factor of 3 and was 600 nT. At the time, near the zenith of Tixie (71.6 N, 128.9 E, L=5.6) at the high-latitude diffuse aurora boundary the discrete wedge-like structures with periodicity similar to geomagnetic pulsations appeared. The boundary of energetic particle precipitations was estimated from spatial-temporal variations of auroral intensity along the north-south direction and its location was varied within geographical latitudes of 70-73 degrees. The riometer absorption pulsations showed the one-to-one correspondence with quasi-periodic oscillations of the auroral precipitation boundary. The possible mechanisms to generate pulsations of Ps6 type and auroral structures are discussed.

Keywords: geomagnetic pulsations, aurora, storm and substorm

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ASIII021 **Oral Presentation** **3465**

Saturation of the polar cap potential: Analysis in terms of Alfvn wave coupling

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The cross polar cap potential varies roughly linearly with the solar wind electric field for nominal conditions but asymptotes to a constant value of order 200 kV for large electric field. When the impedance of the solar wind across open polar cap field lines dominates the impedance of the ionosphere, Alfvn waves incidentfrom the solar wind are partially reflected, reducing the signal in the polar cap. The ratio of the cross polar cap potential to the potential imposed by the solar wind is the ratio of twice the Alfvn conductance of the solar wind to the sum of the Alfvn conductance plusthe Pedersen conductance of the ionosphere. The Alfvn conductance is inversely proportional to the Alfvn speed of the solar wind. As the magnitude of Bsw increases, the polar cap potential first increases linearly with Bsw but ultimately (during major geomagnetic storm intervals) saturates at a level that depends only on the Pedersen conductance of the ionosphere and the solar wind dynamic pressure (plus a small viscous contribution). Quantitative estimates yield saturation levels consistent with observations made during 13 storm intervals. Previous explanations of saturation have invoked changing reconnection efficiency, specific characteristics of the Region 1 current system, or the effect of the bow shock on the reconnecting plasma. Although our relation is mathematically similar to some previously proposed, our arguments place no constraints on reconnection efficiency or on magnetospheric geometry.

Keywords: saturation potential polar, storm electric field

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ASIII021 **Oral Presentation** **3466**

Particle and field characteristics of twelve broadband electron events observed by the FAST satellite during geomagnetic storms

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Broadband electrons are remarkable flux enhancements of precipitating electrons over a broad energy range (50 eV-30 keV) near the equatorward edge of the auroral oval during geomagnetic storms. We identified twelve broadband electron events from the electron energy spectra obtained by FAST during 81 geomagnetic storms between September 1996 and March 2004. Broadband electrons are observed at 53-65 ILAT with latitudinal widths of 1-6. Ground-based magnetic field data show that the broadband electrons tend to occur after the onset of substorms (~5-38 min) during the main phase of geomagnetic storms. These results suggest that intense particle acceleration is occurring in the inner magnetosphere associated with storm-time substorms. For broadband electron events the >1 keV electrons are isotropic except for a loss-cone, whereas below ~1 keV the field aligned electrons are counter-steaming. Intense fluctuations of electric field (>50 mV/m) and magnetic field (>200 nT) and enhanced low-frequency (0-10 kHz) waves are also observed during these events. These characteristics are common for all the broadband electron events. These results may imply that higher-energy electrons are originated from high altitudes in the inner magnetosphere and that lower-energy electrons are accelerated parallel to the local magnetic field at low altitudes near the satellite. In the presentation, we also make comparison between total particle flux and Poynting flux to discuss possibility of particle acceleration through wave-particle interaction.

Keywords: particle precipitation, m i coupling, storm time substorm

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ASIII021 **Oral Presentation** **3467**

Initial results from the SuperDARN Hokkaido radar observation: Intense poleward flows in the dayside cusp region at about 58 geomagnetic latitude

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Initial results of the SuperDARN Hokkaido radar (geographic coordinates: 43.53o,143.61o) will be presented. It is the second mid-latitude SuperDARN radar, and thefirst one in the Asian sector. It started operation on November 20, 2006 after a radiolicense was issued, and became fully operational after December 2. So far we have observed a wide variety of phenomena, such as SAPS/SAID type events, poleward flows near the cusp, dayside/nightside TIDs and so on. In this paper we focus on the poleward flow in thedayside cusp region observed during a large storm on December 14-15, 2006. The Dst index was close to -200 nT when the Hokkaido radar was in the dayside region. The radar observed intense poleward flows up to 1000 m/s, and the flow region ranged from 62o to 58o geomagnetic latitudes. Detailed results of the analyses of the radar data during this storm will be presented.

Keywords: superdarn, hokkaido radar, storm

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ASIII021 **Oral Presentation** **3468**

Low latitude geomagnetic storm signatures during the descending phase of solar cycle 23

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Solar wind magnetosphere coupling mechanism is mainly activated by the energy injection process following the field line merging of the interplanetary magnetic field (IMF) and the earth's magnetic field at the magnetopause. During solar maximum, solar flares, geoeffective CMEs and the intense southward IMF are the dominant interplanetary phenomena causing the development of non-recurrent magnetic storms. In the descending phase of the solar cycle high speed streams emanating from the solar coronal holes produce moderate disturbances in the geomagnetic field on earth. A series of low X-class intensity flares erupted on several occasions during the descending period (2003-2006) of solar cycle 23. Sequence of shock fronts associated with these flares impacted the earth and produced prolonged geomagnetic storm conditions. Rapid solar wind density fluctuations and oscillating nature of the interplanetary magnetic field were a common phenomena found during these storm events selected for the study. Close correspondence between the scintillating nature of the interplanetary magnetic field and the corresponding modulating patterns observed in the digital magnetic records of the equatorial and low latitude stations in the Indian longitude are discussed.

Keywords: flares, magneticstorms, ground magnetic signatures

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ASIII021 **Oral Presentation** **3469**

Study of storm-time dynamics of TEC latitudinal profiles over Europe using GPS measurements

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The GPS measurements from the European permanent network served as a raw data to obtain TEC distribution over Europe. Simultaneous observations from ~150 stations were used to reconstruct the spatial distribution of TEC, that was analyzed as time series at TEC maps. These maps were created with high spatial and temporal resolution. Latitudinal profiles from TEC maps with a one-hour interval were produced for geographic latitude range from 35N to 75N. In the paper, we present the analysis of variations of the latitudinal profiles during different seasons of geomagnetic activity between 1999 and 2005. During day time, the profiles demonstrate monotonously TEC decrease towards high latitudes. The night profiles were more variable. The latitudinal TEC profiles regularly show the main ionospheric trough. The structure of the profiles essentially depended on the dynamics of the trough, which location varied with geomagnetic conditions and local time. Strong gradients of TEC were recognized at both walls of the trough. During severe geomagnetic storms, the latitudinal behavior of TEC was very complex. It was shown that, in the lowest trough location (lower than 50N) the TEC profiles demonstrate the proper structure.

Keywords: tec, storms, gps

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ASIII021 **Oral Presentation** **3470**

Coupling processes and transition from moderate magnetospheric activity

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Disturbances in geospace are due to a number of coupling and interaction processes. The basic coupling process is the solar windmagnetosphere coupling through dayside reconnection, which leads to deviations from energy equilibrium and to the development of the two most prominent disturbance phenomena in the terrestrial magnetosphere: geospace magnetic storms and magnetospheric substorms. The magnetosphereionosphere coupling is of particular importance, since it leads to substantial changes in the inner magnetosphere, which can tune the system response to energy input from the solar wind. The two main system modes of energy dissipation (storms and substorms) can exist independently from each other but can also appear in a synergistic way, which is the focus of this paper. We are presenting and discussing results of both modeling and data analysis that demonstrate the role of coupling processes in the transition from moderate magnetospheric activity (characteristic for substorms) to global magnetospheric disturbances (characteristic for storms). The implications for radiation belt enhancements are also discussed.

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ASIII021 **Oral Presentation** **3471**

The access of solar wind and ionospheric ions to the storm-magnetotail

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We investigate the proportional population of the magnetosphere by ions of solar wind and ionospheric origin during a number of magnetic storms by using the large-scale kinetic (LSK) particle tracing technique. The three-dimensional, time-dependent magnetic and electric fields for this calculation are obtained from a global magnetohydrodynamic (MHD) simulation that uses upstream solar wind and interplanetary magnetic field observations. To study solar wind entry, we launch ions upstream of the bowshock beginning two hours prior to the shock arrival and continuing for eight hours during the sudden storm commencement and the main phase of each storm. The outflow rates and locations of ionospheric O+ ions are specified by the Strangeway et al. [2005] empirical formulae relating outflow to the Poynting flux deposited into the ionosphere and the rate of soft electron precipitation. Results from IMAGE/HENA are used to calibrate the O+ outflow rate and to determine the relative amount of ionospheric H+ in the near-Earth magnetotail during each storm.

Keywords: geomagnetic storms, ionospheric outflow, solar wind entry

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ASIII021 **Oral Presentation** **3472**

Storm-time dynamics of whistler-mode chorus at different scales

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Whistler-mode chorus is an intense naturally occurring wave emission which is known for its dependence on geomagnetic activity, its variability and for its strong interactions with electron populations of different energies. Using data of the four spacecraft of the Cluster mission we analyze measurements of whistler-mode waves and energetic particles at energies 35 - 400 keV during intervalsof high geomagnetic activity. The source region of whistler-mode chorus is identified by the Poynting flux and electromagnetic planarity analysis using multicomponent wave measurements of three magnetic and two electric antennas. During the analyzed intervals the spacecraft are located close to the geomagnetic equatorial plane at a radial distance of 4-5 Earth radii. To investigatetime-frequency properties of whistler-mode chorus emissions we analyzehigh-resolution waveforms recorded in the chorus source. We show that chorus wave packets have a complex internal structure which reflects the microphysics of wave particle interactions during geomagnetic storms.These processes can be important for large-scale storm-time dynamicsinvolving interactions between waves and particles in the inner magnetosphere.

Keywords: wave particle interactions, whistler mode chorus

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ASIII021 **Oral Presentation** **3473**

Coupled Plasmasphere-Ionosphere System during Storm Times: Implications from Coordinated Ground and Satellite Observations

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The plasma distribution in the coupled plasmasphere-ionosphere system can undergo significant changes during magnetic storms, posing a challenging problem to observers and modelers for quantifying all the important physical mechanisms involved. During many magnetic storms, internal depletion occurs within the new plasmaspheric boundary layer, but the responsible physical mechanism for such depletion remains an outstanding problem. In this paper we examine the density variations in the M-I system by studying a collection of ground and satellite observations, including the mass density inferred from resonance sounding, the charge density deduced from whistler traces, ionosonde data, and the RPI observations from the IMAGE satellite. The storm events studied are the major storm in August 2005 (min Dst = -216 nT) and a weaker storm in April 2005 (min Dst = -85 nT). Observations during the August 2005 storm show that the plasmapause moved to L = 2.2 or lower. The density variations in the plasmasphere were mainly controlled by the magnetospheric convection, and the concurrent ionosonde observations in North America indicate a lower F2 layer and less electron content in the ionosphere. By contrast, the plasmapause moved inward only to L ~ 3 during the April 2005 storm. At the L-value of 2.75, which was inside of the new plasmaspheric boundary layer, the equatorial mass density dropped by nearly 50% after the first three days of the storm, but the corresponding charge density decreased by only 25% during the same interval. Our observational results suggest that a concurrent negative ionospheric storm is a likely cause of the internal depletion of the storm-time plasmasphere, a scenario that can be tested by future numerical simulations of the coupled plasmasphere-ionosphere system.

Keywords: magnetic storms, plasmasphere, ionosphere

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ASIII021 **Oral Presentation** **3474**

Motivations and implications for revising the Dst index

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The Dst index is one of the most useful geomagnetic indices which has been constructed to monitor the most dramatic events in the near-Earth space, the geomagnetic storms. However, it has been known for some time that the Dst index includes an excessive, seasonally varying quiet-time level, the so called "non-storm component" which is unrelated to the intensity of the ring current or magnetic storms. We have recently calculated a corrected and extended version of the Dst index, the so called Dcx index for 1932-2005. Here we review the rationale for introducing the Dcx index, and discuss the properties of the Dcx index and the consequences of replacing the Dst index by the more correct Dcx index. While the time evolution of individual storms remains the same, the correction can raise their Dst values by up to 44 nT. The correction has a strong seasonal variation with maxima around the equinoxes, especially in the vernal equinox. The largest monthly correction of about 12 nT is found for March. The average increase of the Dst index is 6.0 nT for all SSC storms, implying a correction of about 23% to the average 7-day storm level, and a 14% correction to the average minimum-Dst value of 42.3 nT for all SSC storms. Thus, the correction affects many earlier storm studies and even the classification of storms to the different intensity levels. Dcx has essentially different properties compared to the Dst index. E.g., the Dcx index correlates better with both sunspots and geomagnetic indices. We discuss these and other implications of substituting the Dst index by the Dcx index.

Keywords: dst index, magnetic storms

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ASIII021 **Oral Presentation** **3475**

Study of the turbulence in the central plasma sheet during August

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Recent studies are shown that the turbulent processes in the space plasmas are very important. It includes the behavior of the plasma sheet plasma during geomagnetic storms. Analysis of plasma velocity fluctuations measured by CLUSTER Ion Spectrometry experiment during August 24-28 geomagnetic storm showed a significant increase in the level of fluctuations. Value of eddy diffusion coefficients increased in 2-3 times during main phase of geomagnetic storm reaching sometimes unprecedented values of ~106 km2s-1, and the turbulence became to be more isotropic. It can be related to the significant increase in the substorm activity, and stretching of the geomagnetic field lines observed during the main phase. On the contrary, subsequent dipolarization produced strong anisotropy in the eddy-diffusion coefficients at the end of recovery phase. This fact is important for understanding of the nature of geomagnetic storms.

Keywords: turbulence, space, plasmas

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ASIII021 **Poster presentation** **3476**

Local time variation of magnetic disturbances and asymmetry of the ring current during super-intense storms (DSt<-250 nT)

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We have studied the ring current asymmetry during super-intense (Dst <-250 nT) magnetic storms. Fifteen superstorms that have occurred during the period 1981-2004 were selected for this study. Geomagnetic indices Dst, SYM-H and ASY-H and the disturbance H-component (dH) of geomagnetic field, as recorded by low-latitude magnetic observatories, are used. We present in this work the relation between ASY-H and SYM-H indices along the magnetic storm and the local time dependence of the dH.

Keywords: geomagnetic storms, ring current, space weather

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ASIII021 **Poster presentation** **3477**

Real-time modeling at the community-coordinated modeling center

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We have recently expanded the availabliity of real-time simulation model runs at the Community-Coordinated Modeling Center (CCMC) to include solar-heliospheric models, an improved-resolution geo-magnetospheric model and several new tools that compute relevant parameters and indices. The new real-time and forecasting tools have been developed upon request by the space weather forecasting community to provide Sun-to-Earth forecasting capability for the first time. We present an overview of the real-rime simulations and of services available at the CCMC including runs-on-request for some 15 models from the solar corona to the Earth's ionosphere through online visualization and offline data interpolation tools.

Keywords: forecasting, space weather, modeling

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ASIII021 **Poster presentation** **3478**

Conjugate ionospheric perturbations during magnetic storms: evidence for stormtime M-I coupling

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In the early phases of a geomagnetic storms, the low and mid-latitude ionosphere are greatly perturbed. Prompt penetration electric fields uplift, perturb, and redistribute the low-latitude ionosphere plasma. In the plasmasphere boundary layer, the sub-auroral polarization stream electric field (SAPS) forms as pressure gradients at the inner edge of the magnetospheric ring current drive Region-2 field-aligned currents into the evening-sector ionosphere. Large poleward-directed electric fields at ionospheric heights are set up to drive closure currents across the low-conductivity region equatorward of the auroral electron precipitation. These large SAPS electric fields map up into the ring current and inner magnetosphere where the inward extent of the SAPS overlaps and erodes the outer plasmasphere and mid-latitude ionosphere, drawing out extended plumes of storm enhanced density (SED). The SED plumes can be used as a tracer of the location and strength of disturbance electric fields. Recent observations indicate that many of these mid-latitude ionospheric disturbance features exhibit degrees of magnetic conjugacy and simultaneity which implicate the workings of electric fields which couple the high and low altitude regions. This presentation will emphasize the combined use of satellite and ground-based observations to investigate the degree of magnetic conjugacy associated with specific features of the stormtime ionospheric perturbation. It is found that features related to the workings of the SAPS electric field - associated with magnetospheric drivers in the stormtime ring current - exhibit clear, striking conjugacy characteristics. TEC enhancements on inner-magnetospheric field lines exhibit localized and longitude-dependent features which are not strictly magnetically conjugate.

Keywords: ionosphere, electric fields, magnetic conjugacy

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ASIII021 **Poster presentation** **3479**

Study on solar sources and polar cap absorption events recorded at Mario Zucchelli Station, Antarctica

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Particularly intense events on the Sun occurred in a period around minimum of solar activity during cycle 23. We investigated the characteristics of these events and the properties of the correlated observations of ionospheric absorption, obtained by a 30 MHz riometer installed at the Italian observatory of Mario Zucchelli Station (MZS-Antarctica), and of geomagnetic activity recorded at Scott Base and MZS (Antarctica). Solar events are studied using the characteristics of CMEs measured with SOHO/LASCO coronagraphs and the temporal evolution of solar energetic particles in different energy ranges measured by GOES 11 and ACE spacecrafts. Analysing these data, we have tried to determine possible clues that could allow a forecast evaluation of the effects produced at the Earths orbit by the interplanetary perturbations. Moreover we have tried to determine as these effects are finally observed on the Earths surface not only in the ionospheric absorption of radio waves and in the intense geomagnetic activity, but also in the significant variations of the cosmic ray modulation, even at high energies.

Keywords: pca, cme, geomagnetism

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ASIII021 **Poster presentation** **3480**

Large-scale electric field in the inner magnetosphere during geomagnetic storms

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It has been well-known from the observation and simulation results that an enhancement of convection electric field in the entire region of the inner magnetosphere and ionosphere takes place during the main phase of geomagnetic storms and that the energetic particles are injected from the nightside plasmasheet into the inner magnetosphere due to the large-scale convection electric field. The recent CRRES [Wygant et al., 1998] and Akebono [Shinbori et al, 2005; Nishimura et al., 2007] satellite observations reveal that a strong large-scale electric field with spatial inhonogeneity is formed in the near-Earth inner magnetosphere in this period. However, due to the lack of the ionospheric electric field observation in the middle-latitude and sub-auroral region, details of time and spatial evolutions of the electric field distribution in these regions during geomagnetic storms have not yet been clarified. In the present study, in order to clarify time and spatial evolutions of the electric field in the middle-latitude, sub-auroral and polar cap ionosphere during the geomagnetic storms, we have performed statistical analysis of the long-term electric field observation of the Akebono satellite for about 7 years from March, 1989 to January 1996. In the present data analysis, we defined the phenomena of magnetic field disturbances indicating the minimum value of less than -40 nT in the SYM-H index as the geomagnetic storm, and selected 1725 cases of the geomagnetic storms during the above period. Here, we defined the periods of dSYM-H/dt<0 and dSYM-H/dt>0 as the main and recovery phases of geomagnetic storms, respectively. Moreover, we divided the recovery phase into two stages: the periods when the SYM-H values give less than -40 nT and more than -40 nT are defined as the early and lately recovery phases, respectively. We also identified the magnetically quiet condition periods when the SYM-H and Kp indices represent more than -10 nT and less than 2. On the other hand, in the electric field data analysis, we used the mapping method into the ionosphere proposed by Mozer [1970], using the IGRF90 model field. During a magnetically quiet condition, the electric field distribution and the potential structure in the high-latitude region of more than 60o show a typical structure of the electric field indicating the two-cell convection pattern. In the polar cap region, the dawn-to-dusk electric field appears with the averaged magnitude of 10.0-20.0 mV/m. In this case, the potential drop in the polar cap region can be estimated as about 26 kV. During the main phase, the electric field intensity in the auroral zone and polar cap region increases by 2-3 times amplitude and the polar cap region expands into the low-latitude region, compared with that during the magnetically quiet condition. In this case, we can estimate the polar cap potential as about 80 kV. Moreover, a new component of the poleward electric field appears in the sub-auroral region in the local time sector between 18 and 24h with the averaged magnitude of 40-60 mV/m without the azimuthal component. On the other hand, the potential distribution of the electric field shows the negative potential stricture in the dawn sector between 03 and 06h with the potential drop of about 4-6 kV. During the early recovery phase, the polar cap boundary moves into the high-latitude region from 70 to 74o and the poleward electric fields clearly appear with the double structure in the auroral zone and sub-auroral region in the dusk sector between 18 and 23h. The poleward electric field in the sub-auroral region can be identified as the SAID/SAPS phenomena. Moreover, in the equatorward region of the poleward electric field, the shielding electric field appears with the magnitude of 5-10 mV/m. During the lately recovery phase, these electric field distributions and potential structure recover to the magnetically quiet level.

Keywords: electric field, geomagnetic storm, akebono satellite

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ASIII021 **Poster presentation** **3481**

Modeling of ring current -multiple phases of the Storm time ring current

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Modeling of ring current -multiple phases of the Storm time ring current Selected magnetic storms (62) during 1985-1999, were modeled for the decay of the ring current during the recovery phase of the storm. Burton et al., (1975) and Dasso et al., (2002) has modeled the ring current during the first 7 to 10 hours of the recovery phase immediately after the minimum Dst value. This present study explains about the attempt made to model the ring current decay during entire recovery phase of the storm. The ring current decay was modeled (Davis and Parthasarathy, 1967), based on the assumption that Dst decreases decays exponentially for the storms Dst > -50 nT and in a linear fashion if the Dst <-50 nT. Based on this assumption the recovery phase of the storm was fitted with single, double and multiple decays. The results of the ring current decay modeling were interpreted in terms of decay coefficients and the decay times for individual storms. From the modeling results the diversity in the decay coefficients was observed. The decay coefficient varies from -0.09 to -0.15 with a duration of 7 to 15 hours for storms with Dst greater than -300nT; -0.03 to -0.4 with a duration of 3 to 40 hours for Dst range -100 to -300nT and the coefficients are even higher for multiple decay events. However, the linear decay coefficients have negligible effect of exponential decay for the selected storms.

Keywords: ringcurrent, recoveryphase

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ASIII021 **Poster presentation** **3482**

Plasma sheet and ionospheric ions contribution to the ring current during storm-time substorms

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In this study we simulate storm-time substorms, by using a three-dimensional dynamic ion-tracing model. We follow the transport and acceleration of ions, under the influence of a background convection electric field with a superposed impulsive electric field due to magnetic field dipolarizations, as observed by spacecraft during substorm expansion. The simulation runs are performed on the Hellas-Grid computing grid to optimize the code efficiency. We examine the relative influence of O+ and H+ ions originating in the plasma sheet and the high-latitude ionosphere on the ring current development. Maps of the temporal and spatial variations of ion energy densities in the inner magnetosphere are constructed. Initial results suggest that the difference in energization is much more prominent for O+ ions, which have been observed to be preferentially accelerated by substorm-induced electric fields.

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ASIII021 **Poster presentation** **3483**

The characteristic time of the magnetospheric ring current decay from experiment and theory

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The magnetospheric ring current particles are the most dynamic part of the Earths radiation belts especially during geomagnetic storms. The processes of the magnetospheric ring current decay are studied as a function of the solar wind electric field. It is shown that the ring current dissipation rate is different during the main and recovery phase of geomagnetic storms. The characteristic time of the ring current decay in the main phase is independent of storm intensity and equals ~ (4 2) hours. Characteristic times of the ring current are different during the first and second step of compound storms, which occasionally results in complex ion composition of the ring current. The characteristic time of the ring current decay in a recovery phase increases with storm intensity. We looked for the acceptable two-step geomagnetic storms and intervals for calculation of the ring current decay. Characteristic times of the ring current are different during the first and second step of compound storms. We examine the ring current ion lifetimes for the possible mechanisms of its decay. Coulomb scattering, charge exchange and plasma instability mechanisms are used for estimation of lifetime of electrons, protons, helium, and oxygen ions. The values of the characteristic lifetime of ring current dissipation obtained from experiment and theory are compared. It is shown that during main and recovery phase of magnetic storm the different mechanisms can play main role in dissipation of the ring current. Very short characteristic decay time during main phase of geomagnetic storms is associated with plasma instabilities. The available ion composition data of the ring current make possible to assume that the ring current decay is accounted for by ion composition variations with changing the intensity (and hence position) of the ring current and/or by a rise of energetic ion fraction on low L-shells.

Keywords: magnetosphere, ring current, characteristic time

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ASIII021 **Poster presentation** **3484**

Variation of the inner radiation belt electron fluxes at low L-shells inside the South Atlantic Anomaly

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Here we study the variation of energetic electron fluxes (E=30 keV 2.5 MeV) in the inner radiation belt at L<2, especially within the South Atlantic Anomaly (SAA) region, during February-May, 2001. This time period contains both geomagnetically quiet intervals as well as major magnetic storms and thus allows to study the effects of geomagnetic activity on the inner radiation belt. In this work we use energetic particle data from the NOAA-15 and 16 satellites, monitoring the particle fluxes in four different local time sectors at the time resolution of about 1 h 40 min. We study the temporal evolution of energetic electron fluxes with respect to geomagnetic activity and solar wind drivers. We analyze the longitudinal and local time distribution of trapped and precipitating fluxes inside and outside the SAA region. We note on the interesting strong local time variation of electron fluxes that is always present at these low L-shells and on the difference in the longitudinal distribution between trapped and precipitating electrons.

Keywords: radiation belt, energetic particles, storms

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ASIII021 **Poster presentation** **3485**

Solar wind parameters at L1 and the response of the magnetosphere: a comparison between two events

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We analyse the response of the magnetosphere for two different periods: 2001 November 23rd -27th and 2005 January 21st-24th. These two far in time periods exhibit very similar profiles in the z-component of the interplanetary magnetic field measured at L1. Similar profiles are also observed in solar wind velocity and in ram pressure. However, the geomagnetic activity, measured by different indices, is not equivalent at all. A detailed comparison between both events guides us to some advances in the understanding of the solar wind-magnetosphere interaction.

Keywords: geomagnetic storms, solar wind, dst index

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ASIII021 **Poster presentation** **3486**

Relations Between Polar and Equatorial Current Systems Inferred from PC, DST and HASYM Indices

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Transpolar ionospheric current systems generate the main part of the magnetic deflections observed in the central Polar Cap. The recorded deflections are used to calculate the dimensionless Polar Cap PCN (North) and PCS (South) indices, which are both scaled to equal in a statistical sense the interplanetary merging electric field (MEF) measured in mV/m. The merging electric field derived from the solar wind speed and the magnitude and direction of the interplanetary magnetic field is also a decisive parameter for the occurrence frequency and the level of disturbance of substorms and for the growth of the equatorial ring current. The magnetic disturbances associated with the ring current are used to produce the Dst index which is often used as an indicator of the global magnetic storm level. The Dst index values reflect hourly averages of the symmetric ring current disturbances, while the HSYM and HASYM indices also derived from low-latitude magnetic recordings provide 1-minute samples of the symmetric as well as the asymmetric magnetic disturbances associated with the ring current. We have used the relations between PCN, PCS, and the Dst, HSYM and HASYM indices to illustrate the close relations between the transpolar current and the equatorial ring current systems both being activated by the interplanetary merging electric field. The presentation shall report our results and illustrate our concept of the total coupled magnetosphere-ionosphere current system in effect during magnetic storm conditions.

Keywords: solar wind, polar cap current, ring current

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ASIII021 **Poster presentation** **3487**

Correlation between interplanetary plasma parameters and AKR emission during magnetic storms

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Several phenomena could be better studied and even disclosed after the development of the satellites and spacecrafts. Auroral Kilometric Radiation (AKR) is one of these phenomena, since its typical frequencies <verbetes>are</verbetes> too low to penetrate earthward across the ionosphere. It has been widely accepted that the AKR is a manifestation of the substorm activity. In fact, AKR is sometimes used as a reliable indicator of the auroral substorm activity. Recent studies showed that AKR disappears in the initial and main phases of some magnetic storms, in spite of the large enhancement of AE index and field aligned currents. During the recovery phase, the radiation strongly activates. Observations indicate that the field-aligned electric field, which accelerates precipitating electrons and <verbetes>drives</verbetes> field-aligned currents, is not formed in the initial and main phases of magnetic storms where AKR disappears. In this paper, we analyze the behavior of the AKR during nine magnetic storms. These events were selected considering that it was possible to obtain the AKR spectrograms, space <verbetes>plasma</verbetes> parameters and the geomagnetic indices AE and Dst. A numerical AKR index (ranged from 0 to 10) was developed, based on the intensity of the auroral radiation shown by the AKR dynamical spectra. Among the selected events we found ones where AKR is present all the way during a magnetic storm (numerical AKR index 0), others where AKR is suppressed during the initial and main phases of the storms (numerical AKR index = 0). The correlation between the numerical AKR index and the space <verbetes>plasma</verbetes> parameters is presented, showing that the best correlation is obtained with the <hm>solar</hm> wind speed. The main parameter associated with the presence or absence of AKR is the density in the <verbetes>plasma</verbetes> sheet.

Keywords: akr, field aligned current, density

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ASIII022 **3488 - 3505**

Symposium
Perspectives from global models and synoptic observations (Divisions III and II)

Convener : Dr. Stefan Eriksson
Co-Convener : Dr. Jesper Gjerloev

The dramatic and ongoing improvements in both ground-based and space based observational capabilities allow more complete and stringent comparisons with global models and simulations to test our understanding of fundamental physical processes. Technological advancements in data storage, retrieval, and communications, new space-based imagning techniques, and ever more cost effective and efficient sensors make collecting more data from more platforms, and the integration of that data into the framework of worldwide virtual arrays an increasingly easy task. In addition, the international modeling community is constantly improving the capacity to integrate data from disparate types of instruments and the assimilation of the resulting product into physical and empirical models. This symposium will highlight research using global scale ground-based and space based observations to study the global and meso-scale system dynamics and also their comparison with global models. In particular, we will focus on synoptic observations provided by remote sensing instruments and arrays of instruments and the integration of these data to provide as complete as possible a specification of the spatio-temporal evolution of the magnetosphere-ionosphere system.

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ASIII022 **Oral Presentation** **3488**

Simulations of Seasonal Variations in MI Coupling

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Significant seasonal variations exist within the coupling of the magnetosphere - ionosphere system. The Russell-McPherron effect attributes a significant portion of this seasonal variation to higher amount of the geoeffective magnetic field in the Parker spiral when rotated into the GSM coordinate system during equinox. Crooker and Siscoe have proposed a mechanism which it explains the variation due to the role of the Earth's dipole tilt in regulating the efficiency of energy transfer at the magnetopause. Ionospheric conductance plays a key role in regulating the rate at which energy can be dissipated in the ionosphere in the controlling mechanism described by Newell. In this presentation we use the the Lyon-Fedder-Mobarry global scale magnetosphere - ionosphere simulation to study these issues. Some care must be taken in the transformation of Parker spiral magnetic field into GSM coordinates within the simulation domain so we have chosen to conduct simulations with the dipole tilt held fixed at three key times, winter solstice, spring equinox, and summer solstice. In the first set of experiments we examine the role of ionospheric conductance by using a ionospheric simulation which includes the effects of solar EUV ionization, which depends upon tilt, and the electron precipitation on the calculation of conductance. The results show a more pronounced substorm during the equinox interval even when the driving conditions have be corrected for the Russell-McPherron effect. In the second set of experiments we replace the ionospheric simulation with a constant conductance ionosphere to examine the role dipole tilt plays in regulating the efficiency of the coupling. The simulation results show that each mechanism plays a role in controlling the interaction between the solar wind and the magnetosphere - ionosphere system.

Keywords: magneosphere, ionosphere, simulation

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ASIII022 **Oral Presentation** **3489**

Ultra Large Terrestrial International Magnetic Array (ULTIMA):A Global Magnetometer Network for Space Physics Research

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The Ultra Large Terrestrial International Magnetic Array (ULTIMA) is a new international consortium that aims at enhancing collaborative research and data exchange on the magnetosphere, ionosphere, and upper atmosphere through the use of ground-based magnetic field observatories. ULTIMA is composed of individual magnetometer arrays in different countries/regions, and it provides a platform for each of them to easily and efficiently collaborate with other arrays in order to expand observational coverage. ULTIMA also helps identify the importance and need of individual arrays to continue operation or establish new stations in their host countries. In this paper we introduce the organization of ULTIMA and its observational coverage. We also describe the plans for data exchange and distribution through individual data servers and virtual observatories, providing opportunities for the scientific community to access an unprecedented amount of integrated ground-based magnetometer observations for heliophysics research.

Keywords: ultra large terrestrial inter, global magnetometer network, new international consortium

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ASIII022 **Oral Presentation** **3490**

The quiet time ionospheric source of ring current plasmas in boundary related coordinates

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Almost all of the ring current plasma comes from the plasma sheet, which is in turn supplied by the ionosphere and solar wind. We know that O+ ions from the ionosphere are present in all regions of the magnetosphere at low levels even during geomagnetically quiet intervals. We also know heavy ionospheric ions such as O+ play a role in the evolution of geomagnetic storms, but we are not sure exactly what that role is. Large-scale modeling efforts constrained by observations provide the fastest path forward to increasing our understanding. One of the obstacles to effectively using the extensive information about ion outflow to constrain large-scale magnetospheric models has been the lack of information about the distribution of the ion outflow in relation to large-scale magnetospheric features such as the auroral oval. We have used data from the Polar satellite to determine the average number and energy fluxes of escaping energetic (15 eV < E/q < 33 keV) H+ and O+ ions in boundary related coordinates during geomagnetically quiet times (Dst < -50). The characteristic energy of escaping ions is determined from the ratio of energy and number fluxes. During quiet times, we found that the characteristic energies in the dayside and nightside auroral regions were moderately uniform. Characteristic O+ energies in the dayside and night side auroral zones are 120 and 700 eV respectively. For H+ the energies are 280 eV and 1.2 keV respectively. We found the most energetic and variable characteristic energies in the polar cap region. Comparison with other observations, including those of thermal O+ from Akebono show that the escaping energetic fluxes in the polar cap are a small fraction (2-3%) of those escaping from the auroral zone. If energization processes acting on auroral field lines above our 1 RE observational altitude are important only during geomagnetic storm intervals, the data presented here almost completely characterize the magnetosphere's ionospheric plasma source during geomagnetically quiet times thus providing an important constraint on large-scale magnetospheric models including mass composition that are in development.

Keywords: ringcurrent, transport, energization

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ASIII022 **Oral Presentation** **3491**

VIrtual observatories and 21ST century data systems

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During the International Geophysical Year (1957-1958), member countries established geophysical observatories around the world. These nations were pursuing major IGY objectives to collect geophysical data as widely as possible and to provide free access to these data for all scientists around the globe. By the beginning of the 21st century, we have achieved an unparalleled ability to acquire data and have attained a good understanding of traditional regions the ionosphere, the magnetosphere, and other such spheres. Much of the new and important science now is coming from the study of the boundaries between these regions and of coupling between geophysical domains. Thus, we need to make data available in a readily accessible form and in much greater quantities to a wider range of scientists than ever before. Several major international initiatives have been proposed to commemorate and to follow on from the original IGY. Scientific societies have promoted the establishment of a system of Virtual Observatories (VxOs). These initiatives have the potential of providing a forward impetus to advances in space science in this century similar to that provided by the IGY fifty years ago. The electronic Geophysical Year (eGY) program, for example, embraces all available and upcoming geophysical data (e.g., atmospheric, geomagnetic, ionospheric, magnetospheric, etc.) and will facilitate the deployment and integration of cross-disciplinary and international virtual geophysical observatories that are deployed in cyberspace. This concept implies a free access to all available data through the Internet and World Wide Web, taking advantage of existing networking infrastructure and software technologies (e.g., Internet, XML, Semantic Web, etc.). Such efforts can be smoothly incorporated into the planned International Years and will provide an international focus for a resolve to address the issues of data release, data discovery, and data preservation. In this talk we present a review and overview of the objectives and successes of the IGY and eGY programs and discuss the relationship of their goals with that of the Heliophysics Great Observatory.

Keywords: datamanagement, virtualobservations, internationalcooperation

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ASIII022 **Oral Presentation** **3492**

Remote sensing the dynamics of the ionosphere-plasmasphere system by ground-based ULF wave observations

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Cross-spectral analysis of ULF wave measurements recorded at ground magnetometer stations closely spaced in latitude allows accurate determinations of magnetospheric field line resonance (FLR) frequencies. This is a useful tool for monitoring temporal and spatial variations of the magnetospheric plasma mass density. The spatial configuration of the South European GeoMagnetic Array (SEGMA, $1.56 < L < 1.89$) offers the possibility to perform such studies at low latitudes allowing to monitor the dynamical coupling between the ionosphere and the inner plasmasphere. As an example of this capability we present the results of a cross-correlation analysis between FLR frequencies and solar EUV irradiance (as monitored by the 10.7-cm solar radio flux F10.7) suggesting that changes in the inner plasmaspheric density follow the short-term (27-day) variations of the solar irradiance with a time delay of 1-2 days. Experimental results are also compared with those provided by a physicalnumerical model of the ionosphere-plasmasphere system. As an additional example we present the results of a comparative analysis of FLR measurements, ionospheric vertical soundings (Rome station) and vertical TEC measurements (from GPS ground stations of the European IGS network) during the development of the geomagnetic storm of 3-4 April 2004.

Keywords: field line resonances, plasmasphere ionosphere, solar irradiance

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ASIII022 **Oral Presentation** **3493**

Global Specification of the Magnetosphere-Ionosphere State with Distributed Space-based Observations and Remote Sensing: Putting Global Simulations to the Test

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Global magnetosphere simulation codes have advanced significantly in recent years and include increasingly comprehensive treatment of magnetospheric processes. An area of improvement that is particularly noteworthy is the recent success of implementing two-way coupling between magneto-hydrodynamic (MHD) models and kinetic simulation codes of the inner magnetosphere, where the MHD equations are insufficient to describe the physics of the natural system. To assess the state of our predictive understanding of the physics in the magnetosphere, it is important to compare the simulation results with observations. Traditionally, few in situ observations have been available for such comparison, so that the modeling campaigns have had to rely on comparisons with sparse observations of the MHD variables. A quantity that is intimately related to the MHD variables and, at the same time, can be derived globally from low-Earth-orbiting (LEO) satellites, are the field-aligned Birkeland currents linking magnetosphere and ionosphere. The Birkeland currents directly reflect the global configuration and energy transport rates, so that data-model comparisons of the current distributions are particularly useful to assess the state of the global simulation codes. A database of more than 3000 reliable global snapshots of the large-scale Birkeland currents has been compiled from combined magnetic field observations by the Iridium, Oersted, CHAMP, and DMSP satellites. This database has recently been analyzed statistically and the dependence of the Birkeland current distributions on solar wind and IMF parameters has been determined. We present the statistical analysis of these observations, comparison of the average Birkeland distributions with global simulation results, and future prospects of expanding the data-model comparisons to include the DC Poynting flux, which can be calculated over large regions from the magnetic perturbations and electric field observations by the SuperDARN radar network.

Keywords: mi coupling, currents

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ASIII022 **Oral Presentation** **3494**

Influence of ionospheric conductance in simulations of the earth magnetosphere-ionosphere system

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foo bar IAGA

Michael Hesse, Maria M. Kuznetsova, Aaron Ridley, Tamas I. Gombosi, Joachim Raeder

In this study we investigate the dependence of the cross-polar-cap electric potential difference as a function of ionospheric conductance by using global magnetosphere models resident at the Community-Coordinated Modeling Center (CCMC). The models are run with constant solar wind conditions that include sudden changes in the primary geomagnetic driving component B_z from southward to northward and back to southward. The investigation considers the amplitude of the ionospheric electric potentials as a function of not only the level of (constant) ionospheric conductance but also as a function of intrinsic model parameters, such as the grid resolution in the near-Earth magnetosphere. The magnetosphere-ionosphere response to changes in the solar wind B_z is studied as a function of the conductance to determine whether the conductance has a measurable effect on the timing of dynamic processes in the magnetosphere as represented by the models. This study is an important part in scientific validation of model capabilities.

Keywords: ionosphere, conductance, modeling

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ASIII022 **Oral Presentation** **3495**

OpenGGCM comparisons with ionospheric data

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The OpenGGCM is a coupled model of the magnetosphere - ionosphere - thermosphere system. It not only computes the fields and plasma distribution in the outer magnetosphere, but also the coupling with the ionosphere. In doing so it uses a number of sub-models and empirical relationships. In this presentation we compare ionosphere parameters, such as field-aligned currents (FACs), potential, and electron precipitation from a variety of LEO satellites, such as IRIDIUM and DMSP, with model predictions. The comparisons encompass a variety of geophysical conditions, ranging from magnetic quiet to storm conditions. We find that the model generally predicts FAC and potential well, but sometimes displaces the electron precipitation peaks.

Keywords: magnetosphere, ionosphere, simulation

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ASIII022 **Oral Presentation** **3496**

Statistical Study of the Effect of Long-duration, Solar Wind Dynamic Pressure Step Increases on the Transpolar Potential

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It has long been established that the Interplanetary Magnetic Field (IMF) is the major contributor to geomagnetic activity on Earth. Recent studies have shown that the solar wind dynamic pressure can also have significant global effects on the terrestrial magnetosphere. In particular, it has been shown, using Defense Meteorological Satellite Program (DMSP) measurements, that solar wind dynamic pressure enhancements significantly increase the transpolar potential and the solar wind/magnetosphere coupling efficiency. It was previously suggested, based on the DMSP data, that solar wind dynamic pressure fronts induce enhanced magnetotail reconnection. Furthermore, Super Dual Auroral Radar Network (SuperDARN) observations show that solar wind pressure fronts induce significantly enhanced ionospheric convection in the dayside ionosphere, implying an increase in dayside reconnection. Thus both enhanced dayside and magnetotail reconnection, and an increase in polar cap convection and the cross-polar-cap potential, occur after a sharp increase in solar wind dynamic pressure. Case studies of long-duration solar wind pressure steps indicate that the potential first rises in response to the increase in pressure, but gradually subsides a few hours later despite the solar wind pressure remaining high. We conduct a statistical study of the effect of long-duration solar wind dynamic pressure step increases on the transpolar potential temporal evolution. Our results, consistent with the individual case studies, show the transpolar potential increasing after the increase in pressure, reaching a maximum 2-3 hours after impact. It then falls again within one hour perhaps to slightly higher values than before the pressure front impact. The results are discussed in relation to enhancements in magnetospheric reconnection induced by a solar wind pressure front, and compared with the results of a global MHD model.

Keywords: solar wind pressure, cross polar cap potential, reconnection

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ASIII022 **Oral Presentation** **3497**

The global Upper Atmosphere Model: the present state and future perspectives

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The modern state and future perspectives of the global numerical Upper Atmosphere Model of the Earth (UAM) are presented in this work. The UAM describes the thermosphere-ionosphere-plasmasphere system by means of numerical integration of the time-dependent 3D continuity, momentum and heat balance equations for neutral, ion and electron gases and the equation for the electric potential. The variable time and spatial integration steps can be used. Additionally the empirical thermospheric and ionospheric models such as the NRLMSISE-00, the HWM-93 and the IRI-2001 are incorporated in the UAM. This allows using theoretical and empirical models jointly in various combinations and facilitates their intercomparison. The auroral oval parameters and the electric field potential drop across the polar cap are set as the UAM input according to available measurement data or empirical dependences. The upper atmosphere behaviour was modeled by the mean of the UAM for different geomagnetic conditions including quite conditions, equinox and solstice under the maximum and minimum solar activity, magnetic storms. The UAM reproduces the well-known thermosphere ionosphere plasmasphere features and gives a good agreement with available incoherent scatter and satellite measurement data.This work was supported by the Grant No. 05-05-97511 of Russian Foundation for Basic Research.

Keywords: modeling, ionosphere, thermosphere

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ASIII022 **Oral Presentation** **3498**

Non-potential fields and field aligned currents in regular daily variations in observatory and satellite magnetic data

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The analysis of regular daily variations averaged over 132 days is now possible with CHAMP data. We present the results of our spherical harmonic analysis of regular daily variations from observatory data and satellite magnetic data. Emphasis is given to the results for the non-potential field, for the interpretation of the non-potential field in terms of field-aligned currents, and for the separation of internal and external fields.

Keywords: spherical harmonic analysis, field aligned currents, non potential field

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ASIII022 **Oral Presentation** **3499**

Field-aligned and ionospheric currents during northward IMF: Multi-satellite observations and global modeling

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Solar wind magnetosphere - ionosphere interaction processes are frequently studied by observing their effect on the high-latitude ionosphere. Field-aligned currents (FAC) are of special importance because they constitute a direct link between the magnetospheric processes and the ionospheric signatures. High-precision magnetic field measurements made simultaneously from two or three satellites in low Earth orbit allow new approaches in studying the current systems in the polar ionosphere. However, their interpretation in terms of solar wind magnetosphere coupling requires extensive theoretical support, such as provided by global MHD modeling. Reversely the magnetic field observations are important for validation of the global models. We present the results of an investigation of solar wind - magnetosphere ionosphere interaction during northward IMF, based on a combination of global MHD modelling and satellite magnetic field observations. Particular emphasis is put on the effect of the IMF By component. The investigation is based both on real event studies where simulation and observations are compared, and on simulation where only the IMF clock-angle is varied while all other solar wind parameters are kept fixed.We select events where the Oersted and CHAMP satellites cross the polar region simultaneously and with large angles between the two orbit planes. The traditional method to infer field-aligned currents from the along-track derivative of the magnetic measurements can then be extended to a more comprehensive treatment, where the full current system, including both FACs and horizontal ionospheric Hall and Pedersen currents, is determined in a fit to the observed magnetic field. In addition the magnetic field due to the simulated current system can be computed and compared directly to the observations. The approach allows for interpretation in terms of magnetopause reconnection geometry: Due to double-reconnecting field-lines, the NBZ currents can exist both on open and closed field-lines. In addition the existence and geometry of the polar cap is closely connected to the IMF By component and the time-history.

Keywords: facs, modeling, observations

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ASIII022 **Oral Presentation** **3500**

The inertial effects of the auroral thermosphere on the magnetosphere-ionosphere system

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The neutral atmosphere can only respond indirectly to changes in electromagnetic forcing via ion-neutral collisions with the ionosphere; while, within the auroral oval, the ionosphere responds almost instantaneously to the magnetospheric dynamo . The large-scale thermospheric response time can be up to a few hours, and depends on the ion-neutral collision frequency, which depends on the plasma density and relative velocity of the plasma with respect to the neutral gas. However, it is interesting to invert this situation and consider what effect the inertia of the thermosphere could have on magnetosphere-ionosphere coupling. Inertia means that the thermosphere carries a memory of the previous several hours of geomagnetic history. As a consequence, it is not correct to presume that all geophysical parameters are the same just because the geomagnetic driving forces are the same. The instantaneous response of the ionosphere to magnetospheric driving may be the same, but the underlying temperatures, composition and energy dissipation will depend on the previous geomagnetic conditions. Thus the measurable consequences of the forcing under variable conditions will differ significantly from those under steady state conditions. This paper will compare observations from Fabry-Perot Interferometers, radars and magnetometers with the Coupled Thermosphere-Ionosphere-Plasmasphere model to demonstrate the effects of thermospheric inertia on the redistribution of magnetospheric energy in the ionosphere-thermosphere system.

Keywords: thermosphere, ionosphere, energetics

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ASIII022 **Oral Presentation** **3501**

Response in Polar Cap Indices to Solar Wind Dynamic Pressure Variations

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Polar Cap (PC) index values are derived from polar magnetic variations calibrated on a statistical basis such that the polar cap index approximate values in units of mV/m of the interplanetary "merging" (or "geo-effective") electric field (MEF) conveyed by the solar wind. We have examined the possible influence from the solar wind density level and the level of dynamic pressure and observe over a wide range of values little or no effect from variations in these parameters above what could be expected just from MEF changes. Furthermore, the short term variations in the Polar Cap indices at the arrival of discontinuities in the solar wind flow have also been analyzed. We have examined the basis for some of the previously published analyses, which attribute large variations in the polar cap indices to solar wind dynamic pressure variations, and have found inaccuracies in the data analysis that cast doubt on the results. Our main conclusion is that the PC index values respond little to solar wind density or pressure variations except for short-lasting variations at the arrival of solar wind discontinuities, which cause global sudden impulses (SI) or storm sudden commencements (SSC). Even in these events, which have been studied extensively in the past, it is unclear whether the geomagnetic effects are related to the solar wind density or dynamic pressure variations as such or to other properties of the interface between different solar wind regimes.

Keywords: polar cap index, solar wind, dynamic pressure

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ASIII022 **Oral Presentation** **3502**

Ionospheric convection and NBZ field-aligned current response to high-latitude reconnection for changing IMF By conditions

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High-latitude reconnection tailward of the cusps is predicted to occur during northward IMF. Northward IMF conditions are also regarded as favorable in generating northward IMF Bz (NBZ) field-aligned currents (FAC) and convection patterns that deviate from the classical 2-cell system in the polar cap ionosphere. We examine the response of the observed dayside polar cap convection and the corresponding NBZ FAC system for northward IMF and slowly changing IMF By for two case events using SuperDARN and DMSP data. MHD simulation results and Cluster observations in support of high-latitude reconnection are also shown for one case event that connect the high-altitude magnetopause and the low-altitude dayside ionosphere.

Keywords: high latitude reconnection, convection, nbz field aligned current

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ASIII022 **Oral Presentation** **3503**

Effect of solar wind dynamic pressure changes on convection and the aurora: modeling and observations

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Recent studies have shown that solar wind dynamic pressure enhancements can cause very significant perturbations in auroral precipitation and ionospheric currents. It has been reported that pressure enhancements can cause significant and rapid closure of the polar cap and thus reduction in the open flux, widening and strengthening of the auroral oval at all local times, as well as an increase of the cross polar cap potential (CPCP) and the efficiency of coupling of the solar wind to the magnetosphere. The effects are most dramatic during periods of strongly southward IMF Bz but are evident at various degrees under most IMF conditions. Perhaps the most peculiar of the effects is the rapid shrinkage of the polar cap, which occurs together with an increase in the CPCP, as the increased solar wind dynamic pressure impacts the magnetosphere. We investigate the physics driving these responses by comparing observations from the Polar, DMSP, and FAST Spacecraft with the results of the OpenGGCM MHD model, and we identify to what extent the MHD model can reproduce the observed responses. We focus specifically on the CPCP, the area of open flux, and the dynamic evolution of the separatrix boundary. We also use the model to predict various properties (like the precipitating flux) along virtual spacecraft (DMSP and FAST) passes of the oval and compare them directly with the actual observations of DMSP and FAST. We have selected a number of cases where the solar wind dynamic pressure enhancement occurs under negative or near-zero IMF Bz. Initial results indicate that when IMF Bz is steady, either southward or near zero, the model reproduces very well the direction and timing of the change of the open flux and that of the CPCP after the compression. During more dynamic times, specifically when the IMF is varying, the comparisons between the model and observations appear to be less realistic and more work is needed to sort out the different effects.

Keywords: dynamic pressure enhancements, modeling, potential

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ASIII022 **Poster presentation** **3504**

A global model for the geomagnetic noise in the Pc5/Pi3 frequency range for different space weather conditions

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Narrow-band Pc or Pi-type pulsations occur from time to time in the magnetosphere and on the ground, while the broad-band noise is the ubiquitous manifestation of the geomagnetic activity. The geomagnetic noise was continuously recorded for several decades at hundreds of ground stations and many satellites. However, noise parameters have not been still analyzed and summarized in a systematic way. In this study we analyze the parameters of the geomagnetic noise with in the frequency range 1-4 mHz (Pc5/Pi3) from more than 100 observatories from the polar to equatorial latitudes in both hemispheres and in a wide range of MLT in the following way: 1) spectral parameters are estimated in 2-hour running window at each station; 2) signal is decomposed into an elliptically polarized and randomly polarized noisy components; 3) for each component the spectrum is presented in a log-log scale and expanded over Legendre polynomials; 4) for all the coefficients the diurnal, latitudinal and longitudinal distributions are calculated, and regular and irregular components of variations are revealed in dependence on space weather parameters; 5) existence of regions with common sources of ULF oscillations and boundaries between them is estimated with the cross-correlation functions. The results of the analysis are as follows: 1) Average spectral power density, spectral slope, and higher spectral moments are determined not by the geomagnetic latitude of the observation site only, but also by its geographic latitude; 2) There are boundaries in coordinates CGL-MLT separating regions with coherent ULF activity. These boundary regions are characterized by a lower spectral coherence and correlation coefficient, and different spectral and polarization parameters as compared with other regions; 3) Irregular variations of spectral parameters may be characterized by several spatial scales, ranging from global to local, and are partly controlled by the space weather parameters.

Keywords: ulf, noise, space weather

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ASIII022 **Poster presentation** **3505**

Framework atmosphere model modeling environment with tuned system of physical interrelations

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The Framework Atmosphere Model (FrAM) is being developed as the universal modelling tool for the research of interrelation of the broad range of various processes and phenomena in the upper atmosphere.Atmosphere is a complex natural system of many interconnecting elements. The amount of computer models of various atmospheric domains increased greatly in recent decades. But these stand-alone models use simplifying assumptions about the interaction of a particular domain with the rest of the system. For the reliable description and prediction of space weather events, however, it is necessary to take into account such interaction including feedbacks.Hence, it is necessary to use first-principles-based physics models in closed coupling with statistical and/or phenomenological models and satellite and ground-based observations. Because of the complexity of the system it is practically impossible to join all physical domains in a monolithic model code. That is why the universal framework tool is needed that would provide the simple integration of independently developed models of different processes and phenomena for studying of the coupling and inter-dependencies between them. This tool should control the data flow between the data sources and models; and between different models, as well, without being dependent on the internal structure and data processing methods of a particular model.During last years there are several frameworks under development in the area of geophysics. But mostly they represent programming kits to build a model system from scratch. Other ones require powerful supercomputers or distributed multiprocessor systems for operation. For the present moment a simple ready-to-run instrument with moderate hardware requirements is not available for the common researcher.Our system should fill this gap. Its basic structure includes the first-principles-based physics model UAM, which describes the upper atmosphere, ionosphere and plasmasphere of the Earth as a coupled system. The already adjusted system of physical interrelations provides the researcher with a physical modelling environment in which he can place his own model for studying external interdependence of the investigated phenomena. Besides, our framework system can run on the conventional desktop computers, what expands the applications scope of use.The FrAM is organised as the open framework, including the controlling Model Manager and the set of subordinate independent Models of separate atmospheric regions and processes, selected by user during the model configuration stage. These sub-models exchange data through the Manager using the unificated interface. Functionally each Model is a method of obtaining the numerical values of certain set of physical parameters in certain spatial grid nodes. As it's easy to see, the experimental data sources fall into this formal definition as well and they can be integrated into framework system.Additionally the empirical thermospheric and ionospheric models such as the NRLMSISE-00, the HWM-93 and the IRI-2001 are incorporated in the FrAM. It allows using theoretical and empirical models jointly in various combinations to eliminate some of physical feedbacks in order to study their importance. The features of FrAM system organisation and data structure are discussed. This work was supported by the grant N 05-05-97511 of the Russian Foundation for Basic Research.

Keywords: modeling, atmosphere, framework

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ASIII023 **3506 - 3522**

Symposium
Causes and evolution of plasma pressure distributions

Convener : Dr. Larry Lyons
Co-Convener : Dr. Sorin Zaharia

This session will be devoted to recent findings in magnetospheric plasma pressure distri-butions, the mechanisms by which they develop and dissipate and their resulting dynamics. Plasma pressure distributions are one of the key physical elements determining magneto-spheric structure, currents, and instabilities. They control the large and medium scale electric currents including the Birkeland currents, they are the source of the Dst disturbance and they are a major contributor to storm-time auroral energy deposition. The ionosphere and the solar wind are considered as sources of equal importance. Either one is capable of supplying the observed magnetospheric plasma over a broadband of energy spectrum. The results of particle measurements from the latest satellite missions, including observations from remote sensing of energetic neutral atoms give new and extremely important information on the structure, stability and dynamics of plasma pressures during storms and substorms. Papers are solicited that discuss magnetospheric plasma sources, sinks, energization, and transport using experiment, theory and simulation/modeling.

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ASIII023 **Oral Presentation** **3506**

Generation of large-scale field-aligned currents by magnetospheric plasma pressure gradients and topology of high latitude magnetosphere

Dr. Elizaveta Antonova
physics of magnetosphere co-chief of session IAGA

The existence of large-scale plasma pressure gradients along flux tube volume isosurfaces in the conditions of magnetostatic equilibrium leads the appearance of large-scale field-aligned currents. Such gradients appear in the magnetosphere of the Earth due to its topology at high latitudes. Suggested more than ten years ago explanation now has real experimental supports. However the topology of high latitude magnetosphere is not wholly clear till now. Therefore the determination of the position of “roots” of Region 1 currents of Iijima and Potemra continues to be an actual problem of magnetospheric physics. The analysis of results of magnetic field and particle observations demonstrate the possibility of the existence of the high latitude surrounding the Earth continuation of ring current –cut ring current (CRC). Considerable part of auroral oval is mapped on CRC. The analysis of the CRC region stability for large-scale electrostatic disturbances shows that Region 1 and Region 2 currents of Iijima and Potemra can be the manifestation of the magnetospheric eigenmode development.

Keywords: plasma, pressure, gradients

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ASIII023 **Oral Presentation** **3507**

Plasma sheet pressure during magnetically very quiet and active times

Prof. Simon Wing
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Jay R. Johnson

The plasma sheet pressure for magnetically very quiet and active times are investigated with DMSP and in situ satellite observations. The formation of cold-dense plasma sheet ions during northward interplanetary magnetic field (IMF) was investigated. The connection between solar wind ions and plasma sheet cold-component ions is demonstrated. The hot-component ions, which are typically found during southward IMF, are also present during northward IMF. The densification of the plasma sheet can be attributed to the influx of the cold-component (magnetosheath/solar wind origin) ions. The cooling of the plasma sheet can be attributed not only to the influx of the solar wind ions, but also the cooling of the hot-components. In the immediate aftermath of the IMF northward turning, the cooling of the hot components can play a more significant role before the arrival of the bulk of the cold components. Order of magnitude calculations of plasma sheet filling rate from reconnection and diffusion suggest that both entry mechanisms could result in roughly comparable filling rates. Hence, the dawn-dusk asymmetries would be key in distinguishing the roles of the various proposed entry mechanisms. The specific entropy of the northward IMF plasma sheet and Birkeland current generations are discussed. To investigate the plasma sheet during active times, four substorm phases were defined, namely, growth, expansion, early recovery, and late recovery. The growth phase profiles show that the ion pressure is higher in the inner edge of the plasma sheet. The premidnight pressure enhancement can be attributed to the temperature enhancement while the postmidnight pressure enhancement can be attributed to the density enhancement. The temperature enhancement at premidnight has been previously reported and attributed to the curvature and gradient drift of the ions. The postmidnight density enhancement may result from the enhanced convection. The profiles show that the ion pressure near the midnight meridian in the midtail region increases right after the substorm onset, during the expansion phase. The pressure subsequently declines during the early recovery phase and declines further during the late recovery phase. This near midnight pressure enhancement during the expansion and recovery phases can be attributed to the temperature enhancements. The 2-D pressure, temperature, and density profiles can provide observational constraints to the competing substorm theories.

Keywords: plasmasheet, pressure

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ASIII023 **Oral Presentation** **3508**

Equatorial ion plasma sheet, its dawn-dusk asymmetry, and associated source locations and transport under different interplanetary conditions

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Larry R. Lyons, James M. Weygand, Tsugunobu Nagai, Richard W. Mcentire

To understand the plasma sheet ion distribution (X > 30 RE), its underlying source locations and transport paths, and how they depend on different interplanetary parameters, we have investigated 11 years of Geotail data corresponding to 16 different interplanetary conditions with each of them a combination of four interplanetary parameters in their low or high value range: (1) IMF Bz direction (> or < 0), (2) |IMF Bz| (0 to 2 or 2 to 8 nT), (3) solar wind density (Nsw, 0 to 6.5 or 6.5 to 15 cm3), (4) solar wind speed (Vsw, 0 to 400 or 400 to 800 km/s). We found that an increase in Nsw (Vsw) mainly leads to higher plasma sheet density Nps (temperature Tps). Nps increases with increasing northward |IMF Bz| but remains similar with increasing southward |IMF Bz|. Tps increases with increasing southward |IMF Bz| but decreases with increasing northward |IMF Bz|. For all conditions, Nps is higher near the flanks than near midnight. A dawn-dusk asymmetry is generally seen in the near-Earth plasma sheet (X > 15 RE) with higher Nps on the dawn than on the dusk side but with higher Tps on the dusk side. As a result, the ion pressure is less asymmetry. The Nps (Tps) asymmetry intensifies with increasing Nsw (Vsw). We evaluated the electric and magnetic drift paths from observations and the comparisons of the paths with the observed phase space density distributions indicate the majority of the low-energy ions are from the flanks while the majority of the high-energy ions are from the tail. The results also indicate that the Nps and Tps dawn-dusk asymmetries result from magnetic drift, not from a dawn-dusk asymmetry in the number of source ions.

Keywords: plasmasheet, pressure, transport

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ASIII023 **Oral Presentation** **3509**

Observation of two distinct cold, dense ion populations at geosynchronous orbit: local time asymmetry, solar wind dependence and origin

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Michelle F. Thomsen, Simon Wing, Masaki Fujimoto, Michael H. Denton, Joseph E. Borovsky, Arne Aasnes, Kanako Seki, James M. Weygand

We report on the observation of two distinct cold (Ti < 5 keV), dense (Ni > 2 cm-3) ion populations at geosynchronous orbit. The first population, which has previously been reported in several studies, is observed in the midnight region of geosynchronous orbit. The second population, which has drawn less attention, is detected on the dawn side of geosynchronous orbit. No such cold, dense population is observed on the dusk side of geosynchronous orbit on a frequent basis. The temporal evolution of various plasma parameters as a function of local time shows that the two populations appear at geosynchronous orbit as distinct populations, since the appearance of a midnight population is not usually associated with that of a dawn population, and vice versa. The midnight ion population is typically observed after the IMF has been northward for some time. It is interpreted that the source of the midnight population is the cold, dense plasma sheet (CDPS). The dawn-side cold and dense ion population is associated with previously strong southward IMF and geomagnetic activity. It is unlikely that this dawn population is simply the low-latitude boundary layer (LLBL) moving closer to Earth because (1) no symmetric dusk population is observed and (2) on average a small sunward flow (~15 km/s) is observed for those events. Since the dawn population is observed only around the end of the main Dst decrease, it is concluded that this population does not typically contribute to the main phase of the storms. This population may rather be transported to geosynchronous orbit by means of a compression and convection enhancement in the magnetosphere, with a preferential access from the dawn flank with no apparent counterpart at dusk.

Keywords: plasma sheet, ring current, source population

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ASIII023 **Oral Presentation** **3510**

Relationship between electromagnetic fields and plasma pressure distributions in the inner magnetosphere

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Pontus C. Brandt, Mei-Ching Fok

The transport of plasmas and the resulting plasma pressure distribution in the magnetosphere are controlled by magnetic and electric fields in which the particles are embedded. Effects of global electric and magnetic fields on plasma pressure distributions in the inner magnetosphere will be investigated in this study through the Comprehensive Ring Current Model (CRCM), which achieves the self-consistency in the electric field by considering the coupling between the ring current and region 2 field-aligned current. For effects of the electric field, we will focus on how sub-auroral conductance controls the global electric field, and how the electric field subsequently affects the plasma pressure distribution and its global consequences in the dynamics of the ring current, sub-auroral ion flows and region 2 field-aligned current. This is done through a case study (12 June 2005) where multiple datasets are available to facilitate the model and data comparison. Both the distribution and value of the sub-auroral conductance will be varied for a better understanding of the involved physical mechanisms. For effects of the magnetic field, we will compare how different empirical models (such as T96 and T05S) and varying different controlling parameters using the same model (e.g., T05S) modulate the distributions of plasma pressure and the coupled ring current and ionospheric dynamics.

Keywords: electromagnetic fields, plasma pressure

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ASIII023 **Oral Presentation** **3511**

Pressure distribution investigations using the Rice Convection Model

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Stanislav Sazykin, Richard Wolf, Robert Spiro, Vinod Kumar

The RCM has been developed specifically to treat the unique and complicated plasma population of the inner magnetosphere. It represents the magnetospheric plasma distribution in terms of multiple fluids with equations and numerical methods specifically designed for accurate treatment of the inner magnetosphere, including the flow of electric currents along magnetic field lines to and from the conducting ionosphere. The RCM computes these currents and the associated electric fields self-consistently. We will present insights gained from using the RCM to study the structure of the inner and middle plasma sheet, using self-consistent magnetic fields obtained by coupling the RCM to global MHD codes and also to an equilibrium solver.

Keywords: plasmasheet, magnetosphere, simulation

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ASIII023 **Oral Presentation** **3512**

Magnetosphere-ionosphere responses to the large and sharp solar wind dynamic pressure changes under the different Bz IMF orientation: case studies

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Georgy Zastenker

Large and fast solar wind dynamic pressure changes as well as southward orientation of the interplanetary magnetic field (IMF) can lead to theimportant large-scale disturbances of the magnetosphere-ionosphere system. Change in the solar wind dynamic pressure results in the compression/decompression of the magnetosphere while prolonged southward IMF orientation leads to the substorm or magnetic storm development. We compared magnetosphere-ionosphere responses to the large and fast solar wind dynamic pressure pulses accompanied by northward and southward IMF orientation. We found that growth/drop of solar wind pressure during northward IMF leads to an enhancement/weakening of luminosity intensity at the dayside of auroral oval. Otherwise increase in solar wind pressure during weak southward IMF can serve as a trigger for the pseudobreakup onset and decrease in solar wind pressure weakening auroral activity.Case study has shown that large solar wind pressure pulse arrived during substorm growth phase produced strong dayside auroral activation, which merged together with substorm current wedge, resulted in the further intensification of substorm.

Keywords: solar wind dynamic pressure, imf bz orientation, auroral activity

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ASIII023 **Oral Presentation** **3513**

Evaluation of Region II magnetosphere-ionosphere electrodynamical coupling within the Harang reversal region: initial results

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Shasha Zou, Chih-Ping Wang, Matina Gkiolidou, Craig Heinselman, Mary Mccready, Mike Rouhoniemi

The Harang reversal is a fundamental manifestation of the large-scale plasma transport and the resulting pressure distribution within the tail plasma sheet and the Region II electrodynamical coupling of this transport to the ionosphere. Theory and observations suggests that this transport is directly related to the strength of polar cap convection and in turn to the physics of substorms. This motivates us to study the evolution of the Harang reversal with the strength and changes of convection and in association with substorm and other disturbances. We now have the capability to measure this evolution using SuperDARN radars that are located further sufficiently equatorward to measure the Harang region without encountering the D/E-region absorption that has limited substorm studies with earlier radars and with the new AMISR incoherent-scatter radar in Alaska. We furthermore have the capability of modeling this evolution with the Rice Convection model given realistic longitudinally dependent boundary conditions. We will present observations of the Harang evolution that we have now obtained from the SuperDARN radars and initial modeling results under simplified conditions.

Keywords: plasma sheet, harang reversal, coupling

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ASIII023 **Oral Presentation** **3514**

Interchange model of plasma sheet transport

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Xiaoyan Xing, Gary M. Erickson, Frank R. Toffoletto, Stanislav Sazykin

The "interchange model" of plasma sheet transport posits that transport through the plasma sheet and into the ring current is dominated by earthward motion of "bubbles", which are flux tubes with relatively low values of the entropy parameter PV5/3, where V is the volume of a closed flux tube containing one unit of magnetic flux. The simplest version of the criterion for interchange instability suggests simply that a system is unstable unless the gradients of V and entropy parameter are everywhere parallel, but shear significantly inhibits interchange, and more detailed analysis suggests that interchange instability occurs only if the gradients of V and entropy parameter make an angle that exceeds a minimum value that is 90 degrees for low beta and decreases with increasing beta. We describe a method for estimating the entropy parameter from measurements on a spacecraft in the plasma sheet and discuss injection events in which bubbles are apparently injected earthward. We also propose doing entropy analyses of substorms and storms, comparing the entropy injected earthward in the plasma sheet with the entropy that shows up in the ring current.

Keywords: interchange, plasmasheet

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ASIII023 **Oral Presentation** **3515**

MSH ram pressure bursts - plasma jet interactions with magnetosphere

Dr. Sergey Savin
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We study sharp ram pressure bursts in magnetosheath (MSH), which aren't directly driven by the solar wind (SW) disturbances, and their interaction with magnetosphere. We call such bursts as 'plasma jets', which are regularly detected in the MSH with preference of occurrence behind the bow shock. The typical duration of the jets is up to several tens of seconds. They appear intermittently, exhibiting as their main feature an increase in the ram pressure of 2-3 times above SW and average MSH pressure. About 20% of the bursts impact magnetopause and either come through the magnetic obstacle into the geomagnetic tail or are reflected backward, depending on if the maximum magnetic pressure on their path is smaller or greater than their ram pressure. These intermittent/ transient flow concentrations are opposite to the predictions of gasdynamics and MHD for the transformation of SW kinetic energy into thermal energy at the BS since in the jets the dynamic pressure is rising instead of falling. We infer supporting of the local energy conservation by the standing electric structures, stored the energy at intensity maximums in the interference pattern, formed by the incident on and reflected from the geomagnetic obstacle waves. We disscus the jet accelertion till supersound velocities in the prossess of interaction with geomagnetic field along with the magnetic and plasma pressure reactions on the jet impacts inside the magnetosphere. This work was supported by ISSI and INTAS grant 03-50-4872.

Keywords: pressure bursts, plasm jets, boundary transport

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ASIII023 **Oral Presentation** **3516**

Study of plasma pressure distribution in the inner magnetosphere using the low-altitude satellite data and its relevance for geomagnetic storm/substorm dynamics

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Elizavieta E. Antonova, Jean Michel Bosqued

Plasma pressure distribution in the inner magnetosphere is one of the key parameters for understanding the main magnetospheric processes including geomagnetic storms and substorms. Therefore, during the last decades many efforts were concentrated on the study of pressure distribution in the inner magnetosphere. However, the pressure profiles obtained from in-situ particle measurements by the high-altitude satellites inside the plasma sheet and other regions of the magnetosphere do not allow tracking the pressure variations related to geomagnetic substorm and storm development, because corresponding time intervals generally exceed the characteristic times of the main magnetospheric processes. On contrary, fast movement of low-altitude satellites makes it possible to reconstruct quasi-instantaneous radial or azimuthal profiles of plasma pressure along the satellite trajectory, using the precipitating particle flux data in the regions of isotropic plasma pressure. The low-altitude polar-orbiting Aureol-3 satellite was used for this study. IGRF, Tsyganenko 2001 and Tsyganenko 2004 storm time geomagnetic field models were used for the pressure mapping into the equatorial plane, and also to evaluate the corresponding volume of the magnetic flux tube, and the magnetic pressure. Study of azumuthal plasma pressure gradients showed that these gradients can be a source of the Iijima and Potemras field-aligned current system. Study of radial plasma gradients showed that during quiet geomagnetic condition the profiles obtained coincide with the results obtained previously from the high-altitude measurements. On contrary, the plasma pressure profiles change significantly during the development of storms and substorms. In case of substorms, the modified interchange instability related to the existence of azimuthal plasma pressure gradients and field-aligned currents in equilibrium was proposed as a source of substorm expansion phase onset. Study of the strom-time pressure profiles showed that the plasma pressure profiles became sharper, and the interchange instability develops, when the plasma pressure profile becomes steeper than L^{-7}. Nevertheless, the results obtained depend strongly of the used geomagnetic field model. Unfortunately storm time models of the magnetospheric magnetic field are still under development. We hope that our results will contribute to the development of a magnetically self-consistent approach for inner magnetosphere modeling.

Keywords: pressure, storm, substorm

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ASIII023 **Oral Presentation** **3517**

Inferring the magnetospheric structure from equilibrium modeling with observed plasma pressure input

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Simon Wing, Chih-Ping Wang, C. Z. Cheng

At most times, the average plasma flow energy in the Earths magnetosphere is much smaller than its thermal energy, therefore the magnetosphere is in a quasi-static equilibrium between the Lorentz force JB and the plasma pressure gradient forces. For such conditions, three-dimensional plasma equilibrium modeling is an excellent tool for investigating the magnetospheric structure. We have developed such an equilibrium model, in which the 3-D magnetic field is computed in force balance with input pressure distributions, which can be taken from satellite observations. The pressure is only needed at one point on each magnetic field line, as it is automatically mapped along the 3-D field lines in the course of the computation. Therefore, a by-product of the model is the automatic mapping of limited 2-D pressure observations into a much larger 3-D spatial domain. Besides pressure input, the model also needs boundary conditions for the magnetic field, which are constructed using empirical magnetic field models, which depend on the magnetospheric activity level, as well as the solar wind dynamic pressure and interplanetary magnetic field (IMF). We use the equilibrium model to compute the magnetosphere structure with various observation-based pressure inputs, from both in-situ plasma sheet data (from Geotail and POLAR spacecraft), as well as from low-altitude spacecraft (DMSP). We discuss the dependence of the computed magnetospheric field structure, including the perpendicular and field-aligned currents, on various levels of activity in the magnetosphere (from quiet times to substorm growth phases) and various solar wind conditions. We focus in particular on the role of the plasma pressure in regulating magnetospheric cross-tail and field-aligned electric currents.

Keywords: pressure, equilibrium, magnetosphere

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ASIII023 **Oral Presentation** **3518**

Self-consistent Numerical Modeling Experiments of the Plasma Sheet Influence on the Storm-time Ring Current

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Tim Guild, Margaret Chen, Paul O'Brien, Frank Toffoletto, Richard Wolf

We present results of hypothetical simulations that probe the effect of different plasma sheet source populations on the ring current during magnetic storm main and recovery phases. Our simulation model (the Rice Convection Model-Equilibrium) includes both a self-consistent electric field and a self-consistent magnetic field. Simulations using models without self-consistent fields generally show drift paths in the inner magnetosphere that are unaffected by the phase space densities in the plasma sheet, suggesting a linear relationship between the plasma sheet density and the resulting ring current energy. Self-consistent electric and magnetic fields give rise to negative feedback processes that mitigate the expected effect of increasing the density of the plasma sheet source region. These feedback processes are electric shielding (which opposes the convection electric field) and magnetic field stretching (which enhances the azimuthal gradient curvature drift of particles). The results show that increased plasma sheet density leads to a stronger ring current, but with a significantly weaker-than-linear dependence. On the other hand, the self-consistent magnetic field appears to slow the rate of decay of the ring current during the recovery phase; it does this by inducing electric fields that brings plasma radially inward as the field dipolarizes, and energizes the ring current plasma as the field strength recovers. Interchange instability may also play a role in the recovery phase, since geosynchronous densities and pressures are typically lower during the recovery phase than during the main phase; interchange of low entropy plasma sheet plasma with higher entropy ring current plasma could be a ring current loss process in that scenario. The feedback processes between the plasma and the fields seem to play a very important role in storm dynamics, and we are only beginning to make sense of them.

Keywords: storm, plasmasheet, ringcurrent

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ASIII023 **Poster presentation** **3519**

ULF electromagnetic waves impact on the plasma pressure distribution in the magnetosphere

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Lundin Rickard

The first attempts to estimate the role of the ULF waves pressure in the dynamics of the magnetospheric plasma can be traced back more than 30 years. Over the years the literature on this subject became richer, and one may say that, on the whole, work in this field advanced appreciably. At the same time, as often happens in a successfully developing field, there is a certain tendency to evade particularly difficult problems that seemed exceptionally important not long ago and were actively discussed by the scientific community but nevertheless remained unsolved. As an example, we refer to the problem of the field aligned plasma pressure redistribution under the action of the ULF waves. The theory predicts that plasma pressure maximum appears at the equator of oscillating magnetic shell if the amplitude of electric field oscillations exceeds a quite low threshold. It is surprising that this maximum has not yet been detected by direct measurements. Further, it was assumed that the redistribution of the plasma pressure leads to the pronounced effects of anharmonicity of the ULF waves, but the corresponding observations of the anharmonicity are rather rare still. Significant tasks, disputable issues, and unsettled problems of this kind are discussed in our report. It is inferred that recent progress in the investigation of interplay between the ULF waves and magnetospheric plasma does not eliminate the necessity for careful study of unsolved problems posed in the past. Moreover, the prolonged existence of paradoxes and unsolved problems is undesirable because it is a challenge to our capability for understanding the physics of the magnetosphere. The work was supported by grant RFBR 06-05-64143.

Keywords: waves, pressure

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ASIII023 **Poster presentation** **3520**

The features of the ion plasma pressure distributions in the near Earth plasma sheet

Prof. Novomir Pisarenko
Causes and evolution of plasma pressure distributi magnetospheric phisics IAGA

I.P.Kirpichev, E.E.Antonova, N.L. Borodkova, V.N.Lutsenko, E.I.Morozova, Yu. I. Yermolaev

Simultaneous data of CORALL, DOK-2, SKA-2 and Electron observations of the experiment Interball/Tail probe are used for the investigations of sharp jumps of plasma pressure during geomagnetically disturbed periods. Data of measurements give the possibility to restore the plasma pressure distribution on the geocentric distances 8 - 20RE with rather high accuracy. Plasma pressure profiles are compared with magnetic field measurements and simultaneous measurements of solar wind parameters. Some of the investigated jumps are connected with plasma sheet flapping. It is possible to select events connected with the processes of particle acceleration. Changes of ion and electron spectra are analyzed.

Keywords: magnetosphere, pressure

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ASIII023 **Poster presentation** **3521**

Anisotropic Pressure Evolution

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Yonggang Hu

Based on spacecraft observations of anisotropic pressure, it has been determined that ion cyclotron (and possibly mirror mode) waves limit the pressure anisotropy (ratio of perpendicular to parallel pressure) in space plasmas. We have developed a bounded anisotropy model that models the pressure evolution including the effect of the waves. Recently, we have also investigated the effect of the parallel heat flux and non-steady energy exchange using hybrid code simulations. Here we review the observations and theory, review inferred effects of anisotropic pressure based on anisotropic pressure MHD calculations, and review our recent studies based on hybrid code simulations.

Keywords: anisotropic, pressure, evolution

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ASIII023 **Poster presentation** **3522**

Sharp solar wind ion flux changes as an indication of dense non-CIR's large-scale solar wind

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Mary Riazantseva 1, 2, Georgy Gastenker 1

Existence of sharp and sizeable changes of solar wind ion flux (several times for the several seconds) was found and investigated and considered as a new phenomenon. More than 20000 events with duration about several minutes or even seconds and amplitude dF > 0,5108 cm-2 s-1 were detected from Interball-1 plasma data (1996-2000) with 1-second accuracy. It was found that sharp ion flux changes are not shocks and they are accociated with sharp boundaries of solar wind (from several to few tens gyroradii). Observed structures are mainly density changes, because velocity, temperature and IMF variations are small at these moments. In 95% of cases the changes of solar wind ion flux and of the magnetic field have opposite signs, so there is a tendency to keep the pressure balance. Sharp ion flux changes are usually observed one by one like pulse packet in dense regions with relatively low speed and lightly increased interplanetary magnetic field. Current investigation shows that sharp and sizeable ion flux changes are mostly geoeffective in ULF range (with the not long-lasting effect) and they are associated with turbulent solar wind. Investigated phenomenon does not related to CME (<0.2% of cases) or CIR (< 2% of cases) structures.

Keywords: high density, geoeffectiveness

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ASIII025 **3523 - 3541**

Symposium
Techniques and instrumentation in space plasma physics

Convener : Dr. Alain Hilgers
Co-Convener : Prof. Hermann Luhr

Space and ground based instrumentation has shown significant advances in technology in recent years. These developments enable a new generation both of measurements and of data acquisition and logistical support for ground based instrumentation. Not only have advances been made to improve performance of individual instruments, for example, space based imagers and sensors but also in systems used for ground based systems to enable improved reliability and autonomy enabling large networks of sensors. With these technical deve-lopments new techniques in operation and analysis of data have been developed to take full advantage of the broad range of measurements provided. This session invites papers describing instrument technologies and developments applied to space physics including both space and ground based as well as papers describing new techniques of measurement and data analysis.

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ASIII025 **Oral Presentation** **3523**

New combined sensor for space research

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Laboratory for Eelectromagnetic Investigations Lviv Centre of Institute of Space Research
IAGA

Valery Korepanov, Stanislav Klimov, Fedir Dudkin

The study of wave processes remains one of the principal topics in space plasma science. Practically all scientific satellites launched recently have onboard instrumentation for the measurements of corresponding plasma parameters. Till recently, the experimental study of wave activity was mainly made by measurements of electric and magnetic fields parameters. The electric currents values were mostly calculated using magnetometer data. Numerous attempts to measure directly the spatial current density were initiated as early as in the years 70-ties of the last century. Moreover, it was theoretically shown that, measuring simultaneously the spatial current density plus magnetic field intensity one can immediately find the value of wave vector in plane wave approximation. Also the possibility appears to separate spatial and temporal variations of wave activity in situ using only one satellite with correspondent set of sensors for the measurement of these two physical values. These results strongly stimulated the research under the development of the sensor for in-situ spatial current density measurements. The attempts to create an efficiently operating sensor for current density measurements in space started in early 70-ties of the past century and several versions of such instrument were proposed. The obtained results were not enough convincing, though in some experiments carried out onboard Prognoz-10 and Interball-Tail satellites some promising qualitative estimations of spatial current density in the specific regions of the magnetosphere main bow shock and boundary layer were obtained. Finally, the study executed in Space Research Institute (Moscow, Russia) and Lviv Centre of Space Research (Ukraine) resulted in the creation of a new combined sensor which allows measuring simultaneously fluctuation of the magnetic field, current density and electric potential so called Wave Probe. Additional advantage of this instrument is that it allows also reducing the number of booms for to move away from the satellite body the sensitive sensors, what is especially essential for small satellites. The Wave Probe construction and its main parameters are discussed. This device was installed onboard Ukrainian satellite SICH-1M (launched 24.12.2004) and, in spite of partial failure of the mission due to the third rocked stage misfunction, the reliable measurement results with Wave Probe were obtained The measurements results in space are presented. This study was partially supported by NSAU Contract 1-02/03.

Keywords: space, wave probe, current

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ASIII025 **Oral Presentation** **3524**

Development of a mass spectrometer for medium energy ions

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Ion dynamics in the earths magnetosphere has been the subject of intensive research and many interesting morphologies have been revealed. Solar origin protons and alpha particles with energies of 1keV/nuc and ionospheric heavy ions with the energies of < 1eV attain much higher energies (>100keV), as a result of the acceleration(s) on the way to the ring current region. However, the energisation mechanisms and transport processes of ions are poorly understood; it is partly due to the lack of detailed ion measurements in the medium energy range (10-200keV). Therefore we have developed a medium energy ion mass spectrometer, with future missions (such as cross scale and ERG missions) in mind. The instrument consists of a novel electrostatic analyser (ESA) with 2-pi radian field of view, and a sophisticated Time-of-Flight (ToF) mass spectrometry unit following to the analyser. The ESA has sufficient sensitivity to acquire ion 3D distribution functions (by utilising satellite spin motions) in less than one minute during magnetic disturbance times. Laboratory experiments show the sufficient performance of the ToF unit in discrimination of various ions such as H+, He+, He++, and N+.

Keywords: spaceborne ion measurements, medium energy, mass spectrometry

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ASIII025 **Oral Presentation** **3525**

New technique for imaging velocity distributions of atmospheric neutrals in-situ

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E Peter King, Peter V Amerl

The Atmospheric Neutral Analyzer (ANA) instrument employs a new technique for imaging the 2-dimensional velocity distribution of a neutral mass species in the upper atmosphere in-situ. This instrument combines collimated ionization, radio-frequency mass analysis and CCD particle imaging to provide images of detailed 2D velocity distribution functions of individual mass species. It comprises an entrance aperture, electron source, ion accelerator, a radio-frequency (RF) ion mass analyzer, and an imaging particle detector. The electron source ionizes a collimated fraction of the incident neutral particles while preserving their velocities. The ion accelerator accelerates all ionized neutrals to a fixed energy in the perpendicular direction to the entrance aperture plane. The mass analyzer further accelerates those of a specific velocity (and hence mass) for further detection, using a RF electric field of specific amplitude and frequency. In the imaging particle detector, the detected ions produce charges on the surface of a micro-channel plate (MCP) detector, and a phosphor screen converts these charges to a visual image of the incident velocity distribution and registers the image on a CCD detector.

Keywords: neutrals, upper atmosphere, mass analyzer

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ASIII025 **Oral Presentation** **3526**

The relativistic electron-proton telescope (REPT)

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In order to measure the crucially important high-energy electron (and proton) component in the Earth's radiation belts, there is a need for a carefully designed particle telescope. This is required since the highest energy particles are a source of great concern from the space weather and climate perspective. Their production is the least understood aspect of radiation belt science and it is important that their fluxes and energy distributions be accurately determined. The Relativistic Electron-Proton Telescope (REPT) consists of a stack of silicon solid-state detectors in a telescope configuration, a conical collimator, and a thick case surrounding the detector stack to shield the sensor from penetrating radiation and bremsstrahlung that would cause background. The REPT has an FOV (field of view) that is a circular cone of 30. The instrument will point nearly perpendicular to the spin axis of the Radiation Belt Storm Probe (RBSP) spacecraft and will sample all pitch angles of particles during normal (or nominal) magnetic field orientations. REPT is also a key sensor element in the Mission Opportunity Radbelt Experiment (MORE) onboard the Canadian ORBITALS (Outer Radiation Belt Injection, Transport, Acceleration, and Loss Satellite) mission that will fly at the same time as RBSP. REPT will measure high-energy electrons (up to ~20 MeV) with good sensitivity and will also measure protons to E~100 MeV. The REPT will be used in a closely coordinated way with the Magnetic Electron-Ion Spectrometer that is part of the RBSP proposed payload. The goal for the REPT design is to measure well the directional intensities and energy spectra of ~2 to >10 MeV electrons throughout the slot and outer radiation belt region. To do this, the instrument requires an adequately large geometric factor to get reasonable count rates (above background) at the higher energies and yet must not saturate at the lower energy ranges. Thus, there must be a balance between foreground saturation on the one hand and background dominance on the other. There must be fast enough electronics to avert undue dead-time limitations and chance coincidence effects. Present simulations and lab testing show that a good design has been attained for the RBSP needs.

Keywords: particle, radiationbelts, detection

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ASIII025 **Oral Presentation** **3527**

Effect of photoelectrons on the impedance of the electric field antennas onboard spacecraft: EM-PIC simulation analysis

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The quantitative understanding of the antenna characteristics in space plasma environment is required in the wave data calibration as well as in the antenna design for future satellite missions. In many previous works, antenna is assumed to be an ideal thin conductive wire, totally transparent to the fluid plasma medium. However, in practice antenna surface is a solid body and plasma particles which impinge the surface are absorbed at the surface and contribute to the charging. In the present paper, considering the antenna-particle interactions, we focus on the effects of photoelectron emission on the characteristics of the antenna impedance. We present the three-dimensional electromagnetic PIC simulations which were performed to examine the photoelectron environment around the antenna and its effects on the antenna impedance. We consider a situation that the spacecraft and antenna bodies are immersed in tenuous background plasma and illuminated by the sun, which leads to photoelectron emission. In this situation, conducting bodies are positively charged due to the dominant current of photoelectrons. We performed ES simulations focused on the creation of photoelectron environment and confirmed the charging of the sunlit bodies to the positive potential values with the correct order. We also confirmed the formation of photoelectron cloud around the sunlit surfaces. The sunless case, i.e., non-photoelectron case, is also examined for comparison. In this case, an electron sparse region is created around the spacecraft. After obtaining the plasma environments around the spacecraft and antenna, we move to EM simulations for antenna analysis. To obtain the input impedance of the antenna we adopted the Delta-gap feeding method which has been widely used in the FDTD-antenna analysis in free space. It was found that the electron conduction current flowing between conducing bodies influences the value of impedance below the characteristic frequency of the photoelectron cloud. This effect can be well understood by a RC parallel equivalent circuit. On the other hand, in the absence of photoelectron emission, such modification of the impedance cannot be observed in the frequency range near the electron plasma frequency. This indicates the current due to the actual motion of the dense photoelectrons contributes this impedance modification. We will discuss the dependence of this effect on the static magnetic field and the arrival direction of the sunlight.

Keywords: electric field antenna, pic simulation, photoelectron

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ASIII025 **Oral Presentation** **3528**

Progress in the application of auroral mechanisms to electric propulsion: A VASIMR status report.

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Plasma physics has found an increasing range of practical industrial applications, including the development of electric spacecraft propulsion systems. One of these systems, the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) engine, both applies several important physical processes occurring in the magnetosphere. These processes include the mechanisms involved in the ion acceleration and heating that occur in the Birkeland currents of an auroral arc system. Auroral current region processes that are applied in VASIMR include lower hybrid heating, parallel electric field acceleration and ion cyclotron acceleration. This paper will focus on using a physics demonstration model VASIMR to study ion cyclotron heating (ICRH) similar to auroral zone processes. The production of upward moving ion conics and ion heating are significant features in auroral processes. It is believed that ion cyclotron heating plays a role in these processes, but laboratory simulation of these auroral effects is difficult owing to the fact that the ions involved only pass through the acceleration region once. In the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) we have successfully simulated these effects. The VX-50 and VX-100 VASIMRs use(d) a helicon antenna with 20 kW of power to generate plasma. Both devices then use(d) an RF booster stage that uses left hand polarized slow mode waves launched from the high field side of the resonance. The current setup for the booster uses 2 to 4 MHz waves with 30 kW of power in the VX-50. This is similar to the ion cyclotron heating in tokamaks, but in the VASIMR the ions only pass through the resonance region once. The rapid absorption of ion cyclotron waves has been predicted in recent theoretical studies. These theoretical predictions have been confirmed with several independent measurements. The ion cyclotron resonance heating (ICRH) show an substantial increase in ion velocity. Pitch angle distribution studies show that this increase takes place in the resonance region where the ion cyclotron frequency is equal to the frequency on the injected RF waves. Downstream of the resonance region the perpendicular velocity boost should be converted to axial flow velocity through the conservation of the first adiabatic invariant as the magnetic field decreases in the exhaust region of the VASIMR. This paper will summarize results from high power ICRH experiments performed on the VX-50 using deuterium, neon and argon plasma during 2006. An overview of the way forward will be touched on briefly.

Keywords: vasimr, icrh, electric propulsion

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ASIII025 **Oral Presentation** **3529**

Space weather forecasting by innovative radio and radar probing of the solar corona

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Utilising mathematical symmetries of the Maxwell equations and their concomitant conservation laws for beams of radio waves, we have proposed an augmented repertoire of radio and radar techniques for probing deep space. By combining the ensuing innovative radio techniques, which allow for geometric coding of radar signals, with a wave-kinetic model for elastic and inelastic radar scattering off plasma turbulence in the corona, we have shown that radar probing from Earth of CMEs is a viable concept. Such probing will be attempted by using a combination of powerful radio transmitters in the HF and VHF range and the LOIS, UTR-2, and LOFAR infrastructures. Possible applications of the new technique to space weather forecasting will be described.

Keywords: solar radar, space weather

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ASIII025 **Oral Presentation** **3530**

Magnetometer array data analysis using a wave telescope technique

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We present theory and first results from the application of the wave telescope technique to magnetic field data from the canadian ground-based magnetometer array CARISMA. The wave telescope is an array processing technique, also known as Capon beamformer, which enables us to calculate the spectral power density in frequency and wavenumber domain of a plane wave field measured at several positions in space. This powerful tool has been successfully used in seismology and near earth space physics, and its application to ground-based data opens the door to new studies of propagation properties of coherent plane-wave-like structures. In this case we present first results from the application of the wave telescope to ground-based magnetic field observations of field-line resonances (FLR) in the Pc5 frequency range excited in the Earths magnetosphere. Characteristic for these FLR events are a 180 degrees phase shift of the measured signals in latitudinal direction and a tailward propagation with low azimuthal wavenumbers. This wavenumber as well as the width of the latitudinal phase shift can be derived from the output spectra of the wave telescope. In order to compute these quantities from the power spectrum we introduce a simple model for the observed wave-like structures measured on the ground during FLR events. Since the resolution of the wave telescope is sufficiently good in wavenumber space, several superimposed waves or wave-like structures within a narrow frequency band may be distinguished.

Keywords: ulf waves, wave telescope, array processing

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ASIII025 **Oral Presentation** **3531**

DIAS, European digital Upper Atmosphere Server:a project co-funded by the eContent programme of the European Commission

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The main objective of DIAS (European Digital Upper Atmosphere Server) project is to develop a pan-European digital data collection on the state of ionospheric part of the upper atmosphere, based on real-time information and historical data collections provided by most operating ionospheric stations in Europe (Athens in Greece, Rome in Italy, Ebre in Spain, Juliusruh in Germany, Chilton in U.K, Pruhonice in Czechia, Lycksele in Sweden, Warsaw in Poland, and El Arenosillo in Spain). Based on the raw data collection, DIAS system develops and distributes several products required by various groups of users for nowcasting and forecasting purposes. The DIAS server (http://www.iono.noa.gr/DIAS) operates since May 2005 and the basic products that are delivered are real-time and historical ionograms from all DIAS ionospheric stations, frequency plots and maps of the ionosphere over Europe based on the foF2, M(3000)F2, MUF and electron density parameters, as well as long term and short term forecasting up to 24 hour ahead. The paper reports on the utilization of ionospheric measurements in modelling techniques applied by DIAS for the specification and forecasting of the ionosphere over the European region, giving details on the final products available to DIAS users.

Keywords: ionosphere

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ASIII025 **Oral Presentation** **3532**

Wide band compound magnetometer : a new instrument to investigate magnetic field components of plasma waves

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Measurement of magnetic fields from DC up to several kHz is of major importance to investigate plasma waves and their role in magnetospheric dynamics. Usually this broad frequency range is covered by two different instruments: the fluxgate (FG) and the search coil (SC) magnetometers. Typically SC covers the frequency band from a few Hz to a few kHz. We describe a new generation of compound magnetometer that covers the whole frequency range and therefore ensures the redundancy with the FG. In addition to enable redundancy with fluxgate magnetometer it should be of interest for scientific spacecraft. This new compound magnetometer is based upon especially tailored magnetic concentrators to intensify the magnetic field in the active region where a Hall sensor is implemented to measure from mHz to few Hz, while a coil is wounded around the magnetic core to measure magnetic fluctuations from a few Hz to a few kHz. We have used an especially designed Hall effect sensor thinned down to 70µm. The magnetic concentrator have been designed to provide magnetic gain up to 250. Thus, the sensitivity of Hall sensors can be improved by at least two orders of magnitude. An electronic conditionning, using spinning current method, permits to remove low frequency noise and the offsets. With this new design a Noise Equivalent Magnetic Induction down to 100pTpHz at 1Hz can be reached. On the other hand, an high turn number winding around the core is used to measure ac magnetic fluctuations. This winding is connected with a very low noise preamplifier. A feedback loop is used to remove the natural resonances of the sensor and to ensure a constant gain over 2 frequency decades.

Keywords: magnetometer, wide band, dc ac

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ASIII025 **Oral Presentation** **3533**

Phase calibration of an aperture synthesis imaging array by means of incoherent scattering

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For a radar interferometer, phase calibration is an important, and often challenging technical step to be completed before further progress, e.g. aperture synthesis imaging, can be achieved. We have found a way to achieve phase calibration by means of regular incoherent scattering from the ionosphere. As part of the EASI project (ESR aperture synthesis imaging), we have found that regular incoherent scattering over moderate integration periods (a few to a few tens of seconds) result in quite stable phase differences between the signals seen in the different antennas, even when the coherence (normalized cross-spectrum) is below detectability. Since the transmit beam is the only plausible source of backscattering inhomogeneity which might produce such a cross-correlation, this offers a very simple phase calibration procedure for the interferometer -- the phases of the received signals are adjusted so that the phase differences due to incoherent scattering is zero in all baselines. We present the cross-correlation and phase observations which underlie this calibration procedure, and the resulting enhancement of detected coherence for localized scatterers, including satellites and naturally enhanced ion-acoustic echoes.

Keywords: incoherent scatter radar, interferometry, phase calibration

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ASIII025 **Oral Presentation** **3534**

Mid-continent Magnetoseismic Chain (McMAC): Magnetoseismic Observations and Their Role in Space Weather Research

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The Mid-continent Magnetoseismic Chain (McMaC) consists of nine magnetometer stations that line up along the 330th magnetic meridian in the and . The first station started operation in September 2004, and the installations of all nine stations were completed in August 2006. These systems sample at 2 Hz and monitor the fluctuations of the geomagnetic field caused by space weather phenomena, and they have continuous Internet connection to allow rapid data access. The McMAC stations can connect to the Fort Churchill Line of the CARISMA Array and two IGPP-LANL stations at the same longitude, and the combined magnetometer chain spans between 29.7 and 78.6 corrected geomagnetic latitude, the widest latitudinal coverage at any single longitude. One of the main advantages of this magnetometer chain is its close separation between adjacent stations, enabling the use of the gradient technique to identify field line resonance (FLR) frequencies and estimate the plasma mass density in the magnetosphere. In this paper we present the joint observations by McMAC, CARISMA and IGPP-LANL Arrays, and we show how these observations can be used to monitor the density distribution of the magnetosphere through the two magnetoseismic methods. The normal-mode technique measures the abundant signatures of field line resonance in the dayside magnetosphere and converts the measurements to the equatorial plasma density. The travel-time technique can detect the plasmapause location in the nightside by finding the discontinuity in Pi 2 arrival time across the magnetometer chain. By examining the data intervals at different levels of geomagnetic activity, we find that the results obtained by both magnetoseismic methods are well consistent with the expected plasmapause location. The vast amount of data made possible by the joint observations at the 330th magnetic meridian can enable the studies of plasmaspheric dynamics under different solar, IMF, and ionospheric conditions. Also discussed are other applications of the McMAC data in space weather research and the possible joint observations with satellite missions.

Keywords: magnetometer, space weather, magnetoseismology

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ASIII025 **Poster presentation** **3535**

Experimental studies aiming to development of instrumentation for geomagnetic measurements fluxgate magnetometer

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The instrumentation of saturated nucleus magnetometers is based on the non-linear properties of iron-magnetic materials of high magnetic permeability . The variation of the magnetic saturation created by the excitement of a bobbin in the non-linear region of the hysteresis curve, BxH, generate in the output of the sensor a signal with even harmonics, the basic concept for the detection of a magnetic field. The second harmonic is proportional to the surrounding environmental magnetic field which is highly influenced by the geomagnetic field therefore the other even harmonic components can be disregarded for comparison. The magnetometer output signal can be obtained through the comparison between the second harmonic signal from the sensor coil and the original 2f signal from which the excitation signal f is obtained. The phase differences between the two signals, correspond to the ambient geomagnetic field. The Southern Regional Space Research Center - CRS/INPE - MCT, Santa Maria, has its Southern Space Observatory, in So Martinho da Serra, near the center or in the lowest intensity magnetic field of the South Atlantic Magnetic Anomaly SAMA, in southern Brazil. In this very important region of the planet it is necessary to have reliable and cheap magnetometer instrumentation systems as described here, to monitor the geomagnetic field variations and study space weather phenomena.

Keywords: geomagnetisminstrumentation, fluxgatemagnetometer, amasdatabase

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ASIII025 **Poster presentation** **3536**

Sounding rocket wave electric field observations with a new all-digital, ultra-low noise receiver

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In February/March of 2007 the sounding rocket CHARM (Correlations of High-frequencies and Auroral Roar Measurements) will be launched from Poker Flat, Alaska. This rocket will carry the standard Dartmouth High-Frequency wave Electric field receiver (HFE), a wave-particle correlator to correlate the Langmuir waves with the auroral electrons and a new all-digital, ultra-low noise, precise-bandwidth wave electric field receiver (RX-DSP) which will attempt the first modern rocket-borne measurements of auroral roar. The RX-DSP will feature a high speed 66 MHz, 16-bit analog to digital conversion at the input and flexible programmable all-digital processing. For CHARM, two of these receivers will be flown, using mutually perpendicular double probe antennas which are both perpendicular to the rocket's spin axis, which is aligned with the earth's magnetic field. Each receiver will be tuned with an extremely sharp band pass filter to the typical frequency range of auroral roar observed at ground level in northern Alaska, 2.6-2.9 MHz. These instruments will measure two components of both the wave electric and magnetic field allowing estimation of the polarization and direction of arrival of the roar, as well as its amplitude along all points of the rockets trajectory. Using these measurements, together with electron distribution functions and wave measurements from a ground station, this rocket experiment will serve to answer several outstanding questions about auroral HF emissions. Among these is the question of whether the intermittent nature of auroral roar observed on the ground is due to ionospheric effects or to actual temporal or spatial variations of the auroral roar source. Because ionospheric absorption of these waves is significant, accurate direct measurements with rockets are required to estimate the global power level of these emissions. The direction-finding capability of the CHARM measurements will allow ray tracing to determine the source location, which together with the amplitude data will reveal the source of the intermittency of the ground based observations. Another question CHARM measurements, specifically the direction finding, will allow us to answer concerns the source sizes of the roar emissions and their temporal variation. Furthermore, using the measurements of the electron distribution function in conjunction with the auroral roar measurements, we also hope to determine whether auroral roar is associated with auroral precipitation events such as suprathermal electron bursts or certain segments of inverted-V events or whether the roar is more favorable emitted in the upward current region or downward current region. Lastly, if the rocket penetrates the source region of the roar, the RX-DSP would give us information about the electric fields of the causative upper hybrid waves. Answers to these questions would significantly improve our understanding of auroral roar emissions, as well as highlight the capabilities and possible future uses for the RX-DSP.

Keywords: plasma, waves, instrumentation

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ASIII025 **Poster presentation** **3537**

Optical Mesosphere Thermosphere Imagers (OMTIs) using cooled-CCD detectors to monitor disturbances in the magnetosphere, ionosphere, and atmosphere

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The Optical Mesosphere Thermosphere Imagers (OMTIs) consist of several optical instruments that measure nocturnal airglow emissions from ground-based stations. In this presentation, we describe optical and control systems of nine all-sky monochromatic imagers, four airglow temperature photometers, and a Fabry-Perot interferometer. All of them use highly sensitive cooled-CCD detectors. They are in automated operation in and, to measure two-dimensional patterns of gravity waves and ionospheric disturbances, thermospheric winds, and mesospheric temperatures. We also describe optical system of two new Fabry-Perot interferometers, which will be developed in this year.

Keywords: airglow, cooled ccd, omtis

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ASIII025 **Poster presentation** **3538**

Estimating space and time gradients from multi-spacecraft measurements

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We present a general method - GALS (Gradient Analysis by Least Squares) - for estimating time and space gradients from multi-spacecraft measurements of physical fields. GALS identifies structures in the field data and estimates their velocities. Weights are calculated from the estimated velocities and used by a least squares method to estimate the gradients. To obtain the best possible resolution, a) the gradients are estimated in the frame of reference where a field structure is essentially stationary; b) the weights are used to form a tight space-time window; and c) the gradient estimates are refined iteratively. Error estimates are obtained with Monte Carlo error propagation. We investigate the ability to separate time and space variations in the observed data and analyze the accuracy of the result with respect to noise and the multi-spacecraft configuration. The inclusion of the error estimates is a major improvement of the method and it allows us to extract regions where the results can be trusted. The method has been tested on both synthetic and real data obtained from the Cluster spacecraft. Our results show that GALS is superior to the Curlometer method for estimating the current density on e.g. thin current sheets.

Keywords: multi spacecraft, space time gradients, analysis method

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ASIII025 **Poster presentation** **3539**

Automatic whistler detector and analyzer system network: a new tool for real-time monitoring of the plasmasphere

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AUTOMATIC WHISTLER DETECTOR AND ANALYZER SYSTEM NETWORK: A NEW TOOL FOR REAL-TIME MONITORING OF THE PLASMASPHEREJnos Lichtenberger (1), Csaba Ferencz (1), Lszl Bodnr (2), Arthur R. W. Hughes (3), Andrew B. Collier (3), Craig J. Rodger (4), and Mark A. Clilverd (5)1) Space Research Group, Department of Geophysics, Etvs University, Budapest, Hungary.(2) BL Electronics, Solymr, Hungary.(3) Space Physics Research Institute,University of KwaZulu-Natal, Durban, South Africa(4) Physics Department, University of Otago, Dunedin, New Zealand.(5) Physical Sciences Division, British Antarctic Survey, Cambridge, U.K.The distribution of plasma in the magnetosphere/plasmasphere is not easily measured routinely but is of great value in predicting the space weather of satellites, the insurance of which is ~ 1.8B per annum. Whistlers have been regarded as cheap and effective tools for plasmasphere diagnostic since the early years of whistler research, but it never became a real operational tool due to the required tedious human work. Recently the Space Research Group of Etvs University has developed a new, unique Automatic Whistler Detector and Analyzer (AWDA) system that is uniquely capable to detect and process lightning whistlers with no human interaction, capable to produce real-time plasmaspheric electron density profiles. A spreading network of AWDA systems was setup in Hungary in 2002, now three systems are deployed in Hungary (Tihany, Nagycenk and Budapest), two in Antarctica (SANAE, South Africa and Halley, UK.), one in Dunedin, New Zealand, at Grahamstown and in Marion Island (South Africa). A few more is planned: in Germany, Finland and Palmer (Antarctica, USA). As AWDA Network is now covering both North-South and East-West Hemispheres, it is not limited by diurnal and seasonal variations due to source and propagation effects of whistlers. Part of AWDA system is a high time precision VLF sampler based on GPS controlled ADC, providing ~80 nanosecond measuring accuracy, that allows coordinated, simultaneous measurements within AWDA Network and with external equipments on the ground or space. This presentation we will show the details of an AWDA system and the AWDA Network, its capability and some results.

Keywords: whistler, plasmasphere, electron density

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ASIII025 **Poster presentation** **3540**

In situ space plasma measurements: electron moments from quasi-thermal noise spectroscopy

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Space plasma measurements by classical particle spectrometers and Langmuir probes are intrinsically limited by the spacecraft potential. This limitation does not affect passive wave measurements at long wavelengths, since they perform an average over a large plasma volume. Thermal noise spectroscopy is based on a passive measurement of the plasma wave spectrum with a long electric antenna, and yields directly the density and the kinetic temperature of a stable electron velocity distribution. This technique does not suffer of the difficulties in plasma resonance identification that impede some other wave techniques as the resonance sounder and the quadripolar probe, and, contrary to them, does not perturb the other in-board instruments. Here we will present how we calculate the noise produced with generalized Lorenzian (kappa) distributions [Chateau and Meyer-Vernet, 1991] and apply it for the first time on space measurements using Ulysses data. This form has the advantage of being analytically tractable, while representing rather well the electron distribution in different media such as the solar wind or planetary magnetospheres; indeed, it is not very different from a Maxwellian at low energies but has a high-energy tail with a power law form. Therefore these calculations can be easily used to generalize the theory and its applications to distribution functions having a power law tail. We will also compare these new results to those obtained from the same data set but assuming instead a classical core + halo distribution for the electron velocity, that is a sum of two Maxwellian distributions. With this later method, the only temperature that could be determined with enough precision was the core temperature, while our new processing provides the total temperature of the solar wind electrons.

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ASIII025 **Poster presentation** **3541**

An intelligent instrument Cylindrical Langmuir Probe for the International Space Station

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Dichko Batchvarov, Rumiana Krasteva, Ani Boneva, Gencho Stainov, Stas Klimov

Langmuir probe is a well known instrument and has long been used for space-borne measurements of plasma parameters. However, in the case of the International Space Station we encounter some new problems. For the first time we have an object not only with such size, but also so much consuming and therefore energy emitting. It appears that the station body significantly affects all low-energy components in its close (near-surface) vicinity: neutral gases, plasma and magnetic field parameters. On the other hand, the surface floating potential tends to reach the potential of the solar batteries, about -160V, which leads to serious problems. In order to study these interactions, the plasma-wave complex Obstanovka (Environment) will be operated aboard the International Space Station, consisting of scientific instruments for measuring the wave and plasma parameters in the stations environment. In this complex, two cylindrical Langmuir probes are included which will measure: - thermal plasma parameters in two points (electron temperature from 1,000 to 6,000 K; electron and ion concentration from 1.10**(+9) to 1.10**(+13) per cubic meter) - the stations potential relative to the plasma in the range from -100 to +100 V; - fast fluctuations in the plasma concentration up to 100 Hz. The plasma in the close proximity to the station is expected to be non-Maxwellian, and its parameters and the stations potential - to vary significantly. To provide reliable measurements in such conditions, the possibility is foreseen for updating the modes of operation of the probe from the ground. This paper describes the intelligent cylindrical Langmuir probes for the Plasma Wave Complex, their construction, technical design, algorithm of operation, and the possibility for updating of the modes of operation from the ground using the standard communicational lines.

Keywords: langmuir probe, international space station

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ASIII026 **3542 - 3580**

Symposium
Wave and particle dynamics in the ring current and radiation belts

Convener : Prof. Anthony Chan

Recent studies have shown that wave-particle interactions with ULF and ELF/VLF waves have a major influence on the energization, transport, and loss of ring current and radiation belt particles. Further progress requires continued study of the effects of the waves on the particles, but also a more complete understanding of the basic physics of the waves. We encourage a broad range of papers relevant to the physics of ULF and ELF/VLF waves and their influence on ring current and radiation belt dynamics. Specifically, there will be a significant focus on the generation and propagation of ULF and ELF/VLF waves, on their global morphology, and on their direct effects on particle dynamics. Papers addressing these topics using observations and/or theory and modeling are welcome.

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ASIII026 **Oral Presentation** **3542**

Acceleration and particle loss within the Van Allen radiation belts associated with the Halloween storms of 2003

Dr. Daniel Baker
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Shrikanth Kanekal

During and following the Halloween Storm period (October-November 2003), the Van Allen belt electron population was powerfully accelerated and redistributed inward. From November 1 to November 10, 2003, the outer belt had its center only at about 2.5 RE geocentric distance. As shown in published papers using IMAGE spacecraft data, the Earths plasmasphere was displaced inward (to an unprecedented degree) in late October 2003, and concurrently the whole radiation belt structure was transformed. The region between the Van Allen belts, normally devoid of particles, became the location of highest radiation belt particle intensities. After the magnetosphere relaxed to a more normal outer belt configuration, the new belt of electrons decayed over a period of days to years. We have examined quantitatively the loss rates for electrons seen in the region of $1.5 < L < 3.0$ using SAMPEX observations. We compare these loss rates to those expected from prior observational and theoretical studies.

Keywords: radiationbelts, geomagneticstorms, trappedparticles

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ASIII026 **Oral Presentation** **3543**

Slot Region Electron Loss Timescales due to Plasmaspheric Hiss and Lightning Generated Whistlers

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Physical Sciences Division British Antarctic Survey

Richard B. Horne, Sarah A. Glauert

Energetic electrons (E > 100 keV) in the Earth's radiation belts undergo Doppler-shifted cyclotron resonant interactions with a variety of whistler mode waves leading to pitch angle scattering and subsequent loss to the atmosphere. In this study we assess the relative importance of plasmaspheric hiss (0.1 < f < 2.0 kHz) and lightning-generated whistlers (2.0 < f < 5.0 kHz) in the slot region and beyond. Electron loss timescales are determined using the PADIE code with global models of the spectral distributions of the wave power based on CRRES observations. Our results show that plasmaspheric hiss propagating at small and intermediate wave normal angles is a signifcant scattering agent in the slot region and beyond. In contrast, plasmaspheric hiss propagating at large wave normal angles and lightning generated whistlers do not contribute significantly to radiation belt loss. The loss timescale of 2 MeV electrons due to plasmaspheric hiss propagating at small and intermediate wave normal angles in the centre of the slot region (L = 2.5) lies in the range 1-10 days, consistent with recent SAMPEX observations. Wave turbulence in space, which is responsible for the generation plasmaspheric hiss, thus leads to the formation of the slot region. During active periods losses due to plasmaspheric hiss may occur on a timescale of 1 day or less for a wide range of energies, 200 keV < E < 1 MeV, in the region 3.5 < L < 4.0. Plasmaspheric hiss may thus also be a significant loss process in the inner region of the outer radiation belt during the recovery phase of storms.

Keywords: slot region, plasmaspheric hiss, energetic electrons

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ASIII026 **Oral Presentation** **3544**

Contribution of radial transport to the enhancement of multi-MeV electrons in the slot region during Oct-Nov magnetic storm of 2003

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IAGA

Austin Barker, Daniel Baker, Richard Selesnick, Reiner Friedel

During the geomagnetic storm of October/November 2003, the intensity peak of the outer radiation belt electron moved from its nominal position of L~4 to L~2.5 within a day. This event was correlated with extremely high solar wind speeds and enhanced ULF wave power throughout the inner magnetosphere, both are known to be associated with enhanced radial transport of radiation belt electrons. A modeling effort was made, using the measurements of relativistic electrons at geosynchronous orbit as the source population and solar wind parameters as input to drive the radial diffusion coefficient. We found that the deep penetration of multi-MeV electrons down to L~2.5 could be accounted for the fast inward radial transport mechanism. We should also note that there is some uncertainty in the source population, averaged from several measurements of electrons at different local time at geosynchronous orbit. The impact of such uncertainty will be discussed.

Keywords: ulf, mev electrons, radial transport

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ASIII026 **Oral Presentation** **3545**

Modelling the Earth's outer electron radiation belt using a 1D radial diffusion model with energy-dependent losses due to plasmaspheric hiss

Dr. Mai Mai Lam
Physical Sciences British Antactic Survey IAGA

Richard B. Horne, Nigel P. Meredith, Sarah A. Glauert

Energetic electrons (E>500 keV) in the Earth's outer radiation belt (3<L

Keywords: radiation belt, plasmaspheric hiss, radial diffusion

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ASIII026 **Oral Presentation** **3546**

The ring current instabilities driven by anisotropic particles during geomagnetic storms

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S. V. Singh, R. V. Reddy, G. S. Lakhina

The ring current instabilities driven by the energetic protons and oxygen ions are investigated during magnetic storms. A linear dispersion relation for the quasi-electrostatic waves propagating obliquely to the geomagnetic field and having frequencies greater than the proton cyclotron frequency in the storm-time ring current region is obtained. The real frequency and the growth rate of the instability are obtained by solving this linear dispersion relation. The effect of different anisotropic indices of proton and oxygen ions on the growth rate of the excited modes are studied for different plasma compositions. It is found that these instabilities become most prominent during intense storms.

Keywords: anisotropic particles, ring current instabilities

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ASIII026 **Oral Presentation** **3547**

Energetic particle precipitation into the middle atmosphere triggered by a coronal mass ejection

Dr. Mark Clilverd
IAMAS

Craig J. Rodger, Robyn M. Millan, John G. Sample, Michael Kokorowski, Michael P. Mccarthy, Thomas Ulich, Tero Raita, Andrew J. Kavanagh, Emma Spanswick

Here, we investigate the geographical spread of precipitation into the middle/upper atmosphere as a result of the arrival of a coronal mass ejection (CME) on 21 January 2005. In contrast to previous statistical studies we provide one of the first attempts to describe the geographic and temporal variability of energetic particle precipitation on a global scale using an array of instruments. We combine data from subionospheric VLF radio wave receivers, the high altitude MINIS balloons, riometers, and pulsation magnetometers during the first hour of the event. There were three distinct types of energetic electron precipitation observed, one globally, one on the dayside, and one on the nightside. The most extensively observed form of precipitation was a large burst starting when the CME arrived at the Earth, where electrons from the outer radiation belt were lost to the atmosphere over a large region of the Earth. On the dayside of the Earth (10-15 MLT) the CME produced a further series of precipitation bursts, while on the nightside dusk sector (~20 MLT) a continuous precipitation event lasting ~50 minutes was observed at $2.5<L<3.7$ along with Pc 1-2 pulsations observed with a ground-based magnetometer. These observations suggest the generation of energetic electron precipitation at the inner edge of the outer radiation belt from EMIC wave scattering into the loss cone, and is the most direct evidence to date connecting EMIC activity and energetic precipitation.

Keywords: electron precipitation, geomagnetic storms, emic

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ASIII026 **Oral Presentation** **3548**

Radiation belt electron precipitation into the atmosphere: recovery from a geomagnetic storm

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Mark A. Clilverd, Neil R. Thomson, Rory J. Gamble, Annika Seppl, Esa Turunen, Nigel P. Meredith, Michel Parrot, Jean-Andr Sauvaud, Jean-Jacques Berthelier

Large geomagnetic storms are associated with electron population changes in the outer radiation belt and the slot region, often leading to significant increases in the relativistic electron population. The increased population decays in part through the loss, i.e., precipitation from the bounce loss cone, of highly energized electrons into the middle and upper atmosphere (30-90km). However, direct satellite observations of energetic electrons in the bounce loss cone are very rare. In this study we have analyzed ground-based subionospheric radio wave observations of electrons from the bounce loss cone at L=3.2 during and after a geomagnetic disturbance which occurred in September 2005. Relativistic electron precipitation into the atmosphere leads to large changes in observed subionospheric amplitudes. Satellite-observed energy spectra from the CRRES and DEMETER spacecraft were used as an input to an ionospheric chemistry and subionospheric propagation code, describing the ionospheric ionization modifications caused by precipitating electrons. We find that the peak precipitated fluxes of >150keV electrons into the atmosphere were 3500300el.cm-2s-1 at midday and 18515el.cm-2s-1 at midnight. For six days following the storm onset the midday precipitated fluxes are approximately 20 times larger than observed at midnight, consistent with observed day/night patterns of plasmaspheric hiss intensities. The variation in DEMETER observed wave power at L=3.2 in the plasmaspheric hiss band shows similar time variation to that seen in the precipitating particles. Consequently plasmaspheric hiss with frequencies below ~500Hz appears to be the principal loss mechanism for energetic electrons in the inner zone of the outer radiation belts during this study period.

Keywords: particle precipitation, geomagnetic storms, plasmaspheric hiss

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ASIII026 **Oral Presentation** **3549**

Automatic whistler detector: operational results from New Zealand

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Greg Mcdowell

Whistlers have been regarded as cheap and effective tools for plasmasphere diagnostic since the early years of whistler research. The Etvs University Automatic Whistler Detector (AWD) system has been operating in New Zealand since mid-May 2005. An initial examination found a relatively small number of "false triggers", with the system accuracy being 80%. Statistics from the first 269 days of operation produced 157,183 whistler traces, equivalent to a whistler trace rate of 0.4 per minute. Our whistlers probe a very large range of L-shells (including L=2.5-3.7), and include a significant population of whistler observations occurring during local noon. We find that the whistler rate at Dunedin is fairly similar to the whistler rate reported from Tihany, Hungary, despite there being ~1500 times more lightning at Tihany's conjugate point. Clearly there is no simple relationship between conjugate lightning activity and whistler rates. In this presentation we will present statistics on our observations over the first ~20 months of continuous operation in Dunedin.

Keywords: whistler, plasmasphere, lightning

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ASIII026 **Oral Presentation** **3550**

Solar Wind Driving of Magnetospheric ULF Waves

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Ultra low frequency (ULF) fluctuations (~ 1-15 mHz) in the Earth's magnetic and electric fields have been shown to be a major contributing factor in the dynamics of energetic radiation belt electrons. Furthermore, several observational and theoretical efforts have revealed a strong correlation between various parameters in the solar wind and the generation of low m (azimuthal mode number) ULF wave power in the magnetosphere. The complex nature of solar wind structures makes it difficult to definitively determine which of these solar wind parameters are the most effective in generating ULF wave power in the inner magnetosphere. In an effort to unravel this complex entanglement, we will present results from LFM MHD simulations driven by idealized solar wind conditions. These idealized driven simulations seek to isolate three known external drivers of inner magnetospheric ULF waves: (i) shear waves on the dawn and dusk flanks driven by high speed solar wind streams ; (ii) compressional waves in the dayside driven by impulsive variations in solar wind dynamic pressure ; (iii) variations in the Earth's convection electric field driven by IMF orientation. For each of the three drivers, we will examine the characteristics of these ULF waves important for radiation belt dynamics, namely their generation mechanism, direction of propagation, azimuthal mode structure, spectral distribution, and global distribution (azimuthal and radial extent).

Keywords: ulf, radiation belts

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ASIII026 **Oral Presentation** **3551**

Multi-Station Observations of Whistler-Mode Chorus

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Umran Inan

Whistler-mode chorus waves in the ELF/VLF band are among the most intense magnetospheric emissions. Resonant interactions of whistler mode chorus waves with radiation belt particles provide an important process for electron loss and acceleration. In particular, intense bursts of whistler mode chorus can lead to microburst precipitation of MeV electrons into the atmosphere. Stanford University's array of 10 VLF receivers in Alaska is utilized for direction-finding and ionospheric exit point location of whistler-mode chorus waves from the Earth's magnetosphere. The sites span the L-shells of L = 4 to L = 6. Each receiver records both orthogonal horizontal magnetic components of the chorus waves. All sites use GPS synchronized sampling allowing for the localization of ionospheric exit points from both arrival azimuth and time of arrival delay. Results show exit point variation/migration as well as mode conversion as a function of propagation distance in the Earth-ionosphere waveguide. General trends of semi-continuous emissions as well as discrete burst emissions are examined. Additionally, the subionospheric VLF remote sensing technique is used to detect precipitation of energetic electrons from pitch angle scattering by the chorus waves. The VLF remote sensing technique involves tracking the amplitude and phase of VLF waves from powerful communication transmitters. Electrons that are pitch angle scattered and deposited into the ionosphere create secondary ionization and change the conductivity profile of the ionosphere. The change in conductivity profile is manifested as a change in amplitude and phase of the subionospherically propagating wave of the VLF transmitter signal. This technique is effective in detecting precipitating electrons with energies greater than 100 keV.

Keywords: vlf, chorus, particle precipitation

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ASIII026 **Oral Presentation** **3552**

Electromagnetic ion cyclotron waves and particle precipitation: GOES and FAST results

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Christopher C Chaston, Howard J Singer

One possible contributor to ring current particle loss during the recovery phase of geomagnetic storms is pitch angle diffusion by electromagnetic ion cyclotron (EMIC) wave particle interaction. The instability produces pitch angle diffusion which leads to partial refilling of the loss cone, resulting in the precipitation of keV protons. Experimental support for this mechanism includes the association of sub-auroral proton arcs seen by IMAGE-FUV, indicating proton precipitation, with EMIC waves seen by GOES at synchronous orbit and embedded in radial plasma plume structures seen by IMAGE-EUV. Ground observations of EMIC waveshave also been associated with proton precipitation seen by low Earth orbiting satellites. In this study we consider the association between EMIC waves seen in enhanced plasma structures by GOES and proton precipitation observations by the FAST satellite in aneccentric polar orbit. For example, individual event studies show proton precipitation is observed in the 10 - 40 keV energy range when FAST passes through or nearby the footprint of the GOES geomagnetic field line.

Keywords: magnetosphere, precipitation, waves

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ASIII026 **Oral Presentation** **3553**

Calculations of the diffusion coefficients and electron flux changes caused ULF pulsations

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Xinlin Li, Michael Temerin

Both proposed acceleration mechanisms, radial diffusion and in-situ acceleration, can lead to electron flux changes in the outer radiation belt. In this presentation, we focus on quantifying the contribution of radial diffusion by tracing energetic electrons in a model of magnetospheric ULF fluctuations. The diffusion coefficients for symmetric and asymmetric background magnetic fields are compared to theoretical estimates both for quiet and for active times in terms of ULF fluctuation activity. Electron fluxes are constructed from ensembles of electrons traced under the effect of model field fluctuations. Constructed fluxes are compared to geosynchronous flux measurements. We find that large amplitude ULF fluctuations during active times can produce significant electron transport and flux increases; this radial transport however cannot be described by theoretical approximations of radial diffusion.

Keywords: radial diffusion, diffusion coefficients, radiation belts

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ASIII026 **Oral Presentation** **3554**

Pc 1-2 Waves and Energetic Particle Precipitation During and After Magnetic storms: Superposed Epoch Analysis and Case Studies

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Marc Lessard, Jacob Bortnik, Janet Green, Richard Horne, Daniel Detrick, Allan Weatherwax, Jyrki Manninen, Noel Petit, Jennifer Posch, Mike Rose

Magnetic pulsations in the Pc 1-2 frequency range (0.1-5 Hz) are often observed on the ground and in Earths magnetosphere during the aftermath of geomagnetic storms. We report here on observations during 2005 from search coil magnetometers and riometers installed at three Antarctic stations: Halley, (-62 MLAT), South Pole (-74 MLAT), and McMurdo (-80 MLAT), from similar instruments in the Finnish chain (from 57 to 75 MLAT), and from energetic ion detectors on the NOAA POES satellites. A superposed epoch analysis based on 13 magnetic storms between April and September 2005, as well as case studies, show that narrowband Pc 1-2 waves were rarely if ever observed on the ground during the main and early recovery phases of magnetic storms. However, intense broadband Pi 1-2 ULF noise, accompanied by strong riometer absorption signatures, did occur during these times. As storm recovery progressed, occurrence of Pc 1-2 waves increased, at first in the daytime and especially afternoon sectors, but at essentially all local times later in the recovery phase (typically by days 3 or 4). During the early storm recovery phase the propagation of Pc 1-2 waves through the ionospheric waveguide to higher latitudes was more severely attenuated. These observations are consistent with suggestions that Pc 1-2 waves occurring during the early recovery phase of magnetic storms are generated in association with plasmaspheric plumes in the noon-to-dusk sector, and provide additional evidence that the propagation of waves to ground stations is inhibited during the early phases of such storms. Analysis of 30-250 keV proton data from four POES satellites during the August 24-27 and July 18-19, 2005 storm intervals showed that the location of the inner edge of the ring current matched well with the plasmapause model of OBrien and Moldwin [2003]. Proton precipitation was often observed coincident with intense wave events at Halley; during each event precipitating protons were located at L shells near or up to 1 RE outside the modeled plasmapause, but well equatorward of the isotropy boundary.

Keywords: ulf waves, magnetic storms, riometers

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ASIII026 **Oral Presentation** **3555**

Acceleration of relativistic electrons in the generation process of whistler-mode chorus emissions

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Yoshiharu Omura

We find acceleration of relativistic electrons in a result of a self-consistent particle simulation with a dipole magnetic field model, reproducing chorus emissions with rising tones.While the majority of electrons lose energy contributing to the generation of chorus emissions, a small fraction of resonant electrons having large pitch angle are energized through nonlinear wave trapping by the generated chorus emissions.Especially, we find that a small fraction of resonant electrons are effectively accelerated while they show a characteristic behavior turning their motion from equatorward to poleward during the acceleration process, which is explained by the relativistic turning acceleration (RTA) process.It has been widely accepted that the role of whistler-mode chorus emissions is significant in the acceleration process of relativistic electrons in the Earth's outer radiation belt during geomagnetic storms.The cyclotron resonant interaction is a crucial key to understanding of the acceleration process of radiation belt electrons as well as the generation mechanism of whistler-mode chorus emissions.

Keywords: particle simulation, chorus emissions, particle acceleration

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ASIII026 **Oral Presentation** **3556**

Quarter Waves Detected by Cross-phase Analysis

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We have examined the diurnal variation of the local toroidal field line eigenfrequency at L=3 using cross-phase analysis of SAMNET and MEASURE ground magnetometer array data. On several days the eigenfrequency was remarkably low near the dawn terminator, when one end of the field line was in a dark ionosphere and the other end in a sunlit ionosphere. Later in the morning the eigenfrequency gradually increased to the normal daytime value. This type of diurnal eigenfrequency variation was found in both European and American meridians, and in several seasons (March, June, and December). Ionospheric Pedersen conductivities calculated using the IRI95 model show pronounced asymmetry between both ends of the field line at times when the extraordinary low eigenfrequency events appeared. Our results therefore suggest that quarter-wavelength mode waves are generated when ionospheric conductivities are asymmetric, reverting to half-wavelength mode as the dawn terminator passes both conjugate points. Ground-based magnetometer measurements of local toroidal field line eigenfrequencies are often inverted to infer plasma mass density in the magnetosphere by assuming half-wavelength mode standing field line oscillations. However, the field line eigenfrequency also depends the ionospheric Pedersen conductivity. In particular, we find that there is a threshold of interhemispheric conductivity ratio for the quarter-wavelength mode to be established. Our results therefore show that cross-phase techniques can detect quarter-wavelength mode waves, when the inferred mass density may be over-estimated.

Keywords: quarter wave, ionosphere, magnetosphere

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ASIII026 **Oral Presentation** **3557**

Waves in the Earths Radiation Belt: The Electric and Magnetic Field Instrument Suite with Integrated Science (EMFISIS) on the Radiation Belt Storm Probes

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The physics of the creation and loss of radiation belt particles is intimately connected to the electric and magnetic fields which mediate these processes. A large range of field regimes are involved in this physics from ring current magnetic fields to microscopic kinetic interactions such as whistler-mode chorus waves with energetic electrons. To measure these key field interactions, NASA has selected the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) on the Radiation Belt Storm Probes (RBSP). EMFISIS is an integrated set of instruments consisting of a tri-axial fluxgate magnetometer (MAG) and a Waves instrument which includes a tri-axial search coil magnetometer and which measures AC electric and magnetic fields from 10 Hz to 400 kHz. The broad frequency range of the Waves instrument enables the identification of resonances and cutoffs from Waves to achieve high cadence, accurate plasma density measurements that are essential to RBSP theory and modeling efforts. Of particular interest to the multi-institution EMFISIS team are the interactions of radiation belt particles with various wave modes such as VLF hiss, equatorial magnetosonic waves, electromagnetic ion cyclotron waves, and chorus. Examples of these key areas of radiation belt science along with instrument suite capabilities will be presented.

Keywords: radiationbelts, waves, magneticfields

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ASIII026 **Oral Presentation** **3558**

The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS): A Canadian Small Satellie Mission to the Inner Magnetosphere

Prof. Ian Mann
IAGA

The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS) mission is proposed as a Canadian Space Agency (CSA) satellite mission contribution to ILWS. The ORBITALS is currently undergoing a CSA funded Phase A, and the US Mission of Opportunity 4-instrument payload MORE for the ORBITALS satellite is also undergoing NASA funded Phase A study. The ORBITALS will provide a unique view of the largely previously unexplored inner magnetosphere. Its mission goal to understand the acceleration, global distribution, and variability of energetic electrons and ions in the inner magnetosphere is perfectly aligned with the top geospace priority for the LWS and ILWS programs. In a 12 hour low-inclination orbit, the ORBITALS will come into once daily apogee conjunctions with the extensive ground-based Canadian Geospace Monitoring (CGSM) instrumentation as well as with GOES East and West. Baseline raised perigee will provide both long outer radiation belt dwell times as well as coverage of the outer-most inner radiation belt. In combination, the ORBITALSCGSMGOES conjunctions will provide a unique data set with which to address fundamental radiation belt science questions, such as the competition between ULF and VLF acceleration processes, the role of EMIC and VLF waves in loss, and the relationship between these processes and plasmaspheric cold plasma dynamics. The ORBITALS will also address inter-related science questions about the structure of inner magnetosphere electric and magnetic field structure, plasmaspheric dynamics, including thermal ion injection and loss, and the dynamics of the ring current population in the inner magnetosphere during storms. In combination with the approved NASA LWS RBSP mission, and the proposed Japanese ERG satellite, the ORBITALS-RBSP-ERG three petal constellation will be able to resolve the spatio-temporal ambiguities and global dynamics and morphology of the Earths radiation belts. Science closure will determine the dominant physical processes shaping Van Allen belt dynamics, and the results will lead to improved radiation belt specification models.

Keywords: radiation belts, inner magnetosphere, satellite mission

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ASIII026 **Oral Presentation** **3559**

Morphology of whistler mode chorus and its interactions with energetic electrons

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IAGA

D.A. Gurnett, J.S. Pickett, N.P. Meredith, D. Winningham, N. Cornilleau-Wehrlin, A. Fazakerley

Whistler-mode chorus is receiving increased attention since it was shown that it can play a role in the process of local acceleration of electrons in the outer Van Allen radiation belt. We analyze the data from wave and particle instruments on board the Cluster and Double Star spacecraft to characterize interactions of whistler-mode waves with different electron populations in the source region of chorus. We show that, for average values of the background plasma density, particle populations with energies below 25 keV can contribute to generation of chorus. We observe injected electrons which are time-energy dispersed at energies of tens to hundreds of eV. Our estimation of model parameters of the electron distribution function using a nonlinear maximum likelihood method shows that their temperature anisotropy is very large. Wave properties are analyzed using measurements of waveform and multicomponent power spectra of chorus. We show that sources of intense chorus can be found at larger radial distances than 6-8 Earth radii, leading to lower energies of resonant particles than we expect at radial distances of 4-6 Earth radii.

Keywords: whistler mode, chorus

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ASIII026 **Oral Presentation** **3560**

Ray tracing model of ELF/VLF chorus and comparison to observations.

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Richard M. Thorne, Nigel P. Meredith

Chorus is an intense electromagnetic whistler mode wave in the ELF/VLF frequency range, which is instrumental in controlling the dynamics of the Earths outer radiation belt. Such waves can act as either a loss process for low energy particles, or as an acceleration process for energetic electrons in the recovery phase of storms. In either role, the propagation characteristics, evolution of the chorus wave normal angle, and ultimate damping of the wave play key roles in the interaction of the chorus wave with the energetic radiation-belt particles. In the present work, we combine numerical ray tracing with a Landau damping calculation to infer the complete propagation characteristics of the chorus wave. We use suprathermal flux measurements from the CRRES satellite parameterized by L-shell, MLT, and AE to construct realistic distribution functions which we use in the calculation of Landau damping. Various aspects of a single chorus element are examined, such as the initial wave normal angle distribution, L-shell, and frequency dependence. The properties of our modeled chorus distribution are compared against a statistical distribution of chorus wave power from the CRRES satellite.

Keywords: chorus, raytracing, radiation belts

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ASIII026 **Oral Presentation** **3561**

Properties of electromagnetic chorus related to wave-particle interactions

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Satoshi Yagitani, Yoshiharu Omura, Hiroshi Matsumoto

Chorus emissions are generated by the loss-cone instability of freshly injected 10-40 keV electrons. The emissions have been speculated to parasitically interact with the high energy tail of the electron distribution leading to the acceleration of relativistic electrons. It is the purpose of this work to examine the fine scale structure of chorus elements usingGeotail 3 magnetic and 2 electric component data with the aim of not only elucidating the details of wave generation, but also that ofparasitic interactions. The results of analyses of chorus elements in the depths of the magnetosphere and in and near minimum B pockets will be discussed.

Keywords: chorus, wave particle interactions, hildcaas

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ASIII026 **Oral Presentation** **3562**

Mass and electron densities in the inner magnetosphere during a prolonged disturbed interval

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Russell Grew, Mark Clilverd, Bill Sandel

The inner magnetosphere plasma environment can be rather disturbed during and after magnetic storms. Recent discoveries include plasma structures described as plumes, channels, notches, and shoulders. We studied the equatorial plasma density and composition at L=2.5 during an extended disturbed interval in October 2002 using field line resonance measurements from magnetometer arrays in Europe and Antarctica, naturally and artificially stimulated VLF whistlers recorded in Antarctica, and observations from the IMAGE spacecraft EUV experiment. The first provides information on the plasma mass density in the equatorial plane, the second yields the electron density, and from EUV we obtain the line-of-sight He+ intensity, allowing the He+ density to be estimated. During the storm the plasmapause moved to L<2.5 and at least one density notch and drainage plume formed. These features were evident in all the data sets for some days. One notch extended from 2.4 - 4.5 RE and spanned <4 hours in MLT. Mass and electron densities in the plume were enhanced by a factor of about 3. In the plasmasphere and plasmatrough the H+:He+:O+ composition by number was around 82:15:3. However, just outside the plasmapause the O+ concentration exceeded 50% by number, suggesting the presence of an oxygen torus.

Keywords: plasmapause

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ASIII026 **Oral Presentation** **3563**

Empirical characterisation of ULF wave power: Towards a ULF wave index

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Paul T. M. Lotoaniu, Ian R. Mann, Louis G. Ozeke

Ultra-Low Frequency (ULF) waves are believed to play an important role in the dynamics of the outer radiation belt electrons following geomagnetic storms. The energisation mechanism is thought to be the adiabatic radial transport of electrons inward into regions of higher magnetic field strength, through violation of the third invariant. This transport is generally thought to be diffusive in nature and can be characterised by a diffusion coefficient which is dependent on the ULF wave power. Using ground-based magnetometers, we present statistical ULF wave power distributions parameterised by both solar wind and geomagnetic conditions, and present a model for mapping this power into equatorial electric fields. The empirical relationships presented will be useful for driving radial diffusion models and ultimately for defining a ULF wave index. A ULF wave index which captures the dominant wave power experienced by an electron around its drift orbit would be extremely useful for the purposes of now- and fore-cast modelling of radiation belt dynamics.

Keywords: index, ulf

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ASIII026 **Oral Presentation** **3564**

First simultaneous observations of Magnetospheric Line Radiation (MLR) on the ground and onboard DEMETER satellite

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Magnetospheric line radiation (MLR) was reported for the first time by Helliwell et al. (1975), where it was visible in many of the figures, although at the time it was not recognised for what it was. The recordings were made in 1960s and 70s at Siple, Antarctica and Roberval, Quebec. The authors observed thick magnetospheric lines in the frequency range of 2-5 kHz. The main spacing was roughly 120 Hz, but also fine structures with spacing of 20-30 Hz were observed. Often those lines were fairly constant in frequency but sometimes they drifted up or down in frequency at rates up to 50 Hz/min.Satellite observations of MLR were made in 1980s and 1990s, but simultaneous ground-based observations were missing. Extensive ground-based observations were studied by Rodger et al (1999, 2000a,b). In the present study we are showing the first simultaneous observations of magnetospheric line radiation on the ground in northern Finland (67.74 N, 26.27 E, L=5.45) and DEMETER satellite. MLR event occurred between 1630 UT and 1940 UT on 28 November 2006. It continued more than 3 hours and DEMETER satellite observed similar structure at middle and high latitudes on both hemispheres altogether during three consecutive half-orbits. Difference in UT time between consecutive orbits is about 1 hour and 40 minutes, but local time stays same, i.e. DEMETER is a solar synchronous satellite.Observed MLR event covered the frequency band of 1.0-2.5 kHz. The main spacing was roughly 50-75 Hz. Lines were drifting up in frequency rates of 10-15 Hz/min. The event started and ended gradually on ground-based observations. Simultaneous ground and satellite observations support the idea that MLR appears over wide spatial areas. Then it can widely take part in magnetospheric plasma processes. Detailed characteristics will be shown in the presentation.

Keywords: elf vlf waves, satellite ground observation, mlr

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ASIII026 **Oral Presentation** **3565**

Backward-wave oscillator model for VLF chorus emissions: analytical estimates and numerical simulations

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We review recent results of studying the generation of chorus emssions in the Earths magnetosphere on the basis of the backward wave oscillator regime of the cyclotron interaction of energetic electrons with whistler-mode waves. This regime corresponds to the absolute instability of waves in the near-equatorial region of the magnetosphere. For realistic fluxes of energetic particles, the instability of parallel-propagating whistler-mode waves can become absolute ifa step-like distortion exists in the distribution function of energetic electrons. The model allows us to estimate the scale of the chorus source region, the growth rate, amplitude, characteristic period of succession, and frequency drift of chorus elements. These analytical estimates are confirmed by numerical simulations. Based on the model, we can also assume certain features of spatio-temporal variations of chorus parameters in the source region. In particular, the source region should remain near the local magnetic-field minimum even if the position of this minimum significantly changes in time due to the magnetic-field variations. The model also suggests that different frequencies within an individual chorus element can be generated at different distances from the source center and, therefore, the dynamic spectrum of individual chorus elements can differ noticeably between different observation points in the source region. These features seem to be confirmed by recent analysis of Cluster data on VLF waves, energetic particles, and geomagnetic field.

Keywords: vlf chorus emissions, gyroresonant interactions, radiation belts

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ASIII026 **Oral Presentation** **3566**

Radial transport of relativistic electrons during storms driven by high speed solar wind streams

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Although much has been learned in recent years, our understanding of the basic physical processes responsible for the transport, acceleration and loss of radiation belt particles is still incomplete, and further work is needed to build better physics-based models of radiation belt dynamics. Two classes of mechanisms are thought to be especially important: (1) Local acceleration and loss by cyclotron-resonant interaction with VLF/ELF waves, and (2) radial transport by drift-resonant interaction with electromagnetic perturbations in the ULF frequency range. In this work simulations of radial transport are presented, including results from 1D (plus time) radial diffusion simulations and results from test-particle trajectories in fields obtained from LFM (Lyon-Fedder-Mobarry) global MHD simulations. The simulations are carried out for storms driven by high speed solar wind streams. These storms occur with 27-day periodicity during the declining phase of the solar cycle and they are especially interesting because they often contain very large sustained relativistic electron flux increases. We will report on efforts to find radial diffusion coefficients which best describe the transport of MeV electrons between geosynchronous orbit and equatorial GPS locations (at 4.2 earth radii), two locations where simulated phase-space densities (for given first and second adiabatic invariants) can be compared with spacecraft measurements.

Keywords: radiation, diffusion, ulf

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ASIII026 **Oral Presentation** **3567**

Occurrence of large electric fields at the outer edge of the outer radiation belt

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We study the evolution of the radiation belt edge in the post-midnight sector for two cases, using Cluster and Polar observations. In the first case, at a time of weak substorm onset, the Cluster spacecraft fly in a string-of-pearls formation and cross the radiation belt edge near L=5.7 one by one within one minute while the edge is moving earthward at a speed of about 35 km/s. During the event the edge becomes rapidly steeper in terms of the gradient of energetic particle fluxes, the energetic particle fluxes increase by 2-3 orders of magnitude in the edge, and at the same time electric fields grow from 50 mV/m to near 300 mV/m. The edge is bounded by a steep density cavity that becomes narrower during the event and in order to have a pressure balance the cavity is filled with increasing magnetic fields. In the second event, during a storm main phase, a similar event is observed by Polar so that very steep radiation belt edge near L=4.4 is observed together with very large E-fields of 400 mV/m. However, significant differences between these two events are seen such as E-fields occur in a region of large plasma density and large field-aligned currents and most importantly this time E-fields are modulated by large Pc-1 waves (10-sec waves). In the first event the E-fields are modulated by 1-10 Hz waves but their role if any is unclear. Part of the observational differences may be explained by different spacecraft location, Cluster were at 4.3 Re distance while Polar was only at 2.3 Re distance. It seems as if in the first event large diamagnetic currents and drifts are responsible for controlling the increase of large E-fields and the evolution of the radiation belt edge while in the second event the Region 2 FAC currents affect and possibly drive the large E-fields observations.

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ASIII026 **Oral Presentation** **3568**

Global scale magnetic pressure impulses at the lower magnetosphere-ionosphere boundary

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Pressure pulses in the ULF range can play a very important role in the dynamics and loss of the inner zone radiation belt particles. These impulses can be introduced by sources arising from the solar wind-magnetosphere interactions suitably amplified by cavity resonances throughout the magnetosphere, including the plasmasphere. While there have been numerous surveys of ULF waves in the magnetosphere, statistical studies of pulsations in the innermost regions have relied almost entirely on ground magnetic data. Since the conducting ionosphere can modify or screen the incoming hydromagnetic waves, there is a necessity to confirm and/or extend these results using observations from spacecraft just above the ionosphere. Three low-altitude polar-orbiting spacecraft (Oersted, Champ and SAC-C) have made over a decade of very accurate magnetic field measurements. The present study employs simultaneous Champ and Oersted scalar magnetic field measurements to identify global scale magnetic pressure impulses in the 20-200 mHz frequency domain. Our studies show that the power in these magnetic pressure oscillations peak at frequencies near 50mHz. This peak is almost always observed by both spacecraft even when they are widely separated in both latitude and local time. The relative amplitudes at the two satellite locations vary greatly but the oscillations are often quite coherent and in phase, clearly pointing to the global nature of the possible global resonance supporting them. Apart from the ubiquitous presence of oscillations around 50 mHz, other peaks at higher frequencies also manifest themselves hinting at a possible harmonic structure of the modes associated with the cavity resonances. We will discuss the structure of these oscillations and the possible impact they can have in the diffusion and loss of energetic particles in the innermost regions of the radiation belt plasma.

Keywords: ulf, pressure pulses, global modes

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ASIII026 **Oral Presentation** **3569**

Effects of geomagnetic pulsations on electron precipitation spectra

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Farideh Honary, Andrew Senior

Electrons with energies in excess of 30 keV form a potential source population for relativistic electrons in the outer radiation belt. One loss mechanism of these sub-relativistic electrons from the magnetosphere is precipitation linked to substorm activity, whether directly or following gradient-curvature drift of the freshly injected electron population. This can be observed using cosmic noise absorption measurements from a riometer. The precipitation is caused by the scattering of electrons into the loss cone by VLF whistler-mode waves; however, the precipitation can itself be modulated on timescales of seconds to tens of minutes. Using riometry we compare and contrast pulsation events of relatively short (260 seconds) and long (18 minutes) periods within the precipitation to determine the differences in modulation mechanism. Using incoherent scatter data we investigate the change in energy spectra within the Pc5 pulsation (260 seconds) to determine the effect on the different levels of particle energy. The Coroniti-Kennel theory of ULF wave-electron interaction predicts a change in the shape of the high energy tail; alternatively, a shift in the whole spectrum would indicate that the pulsation in the precipitation is caused by acceleration in a parallel electric field such as that caused by kinetic Alfven wave.

Keywords: geomagnetic pulsation, electron precipitation

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ASIII026 **Oral Presentation** **3570**

Characterizing ULF wave activity during geomagnetic storms driven by high speed solar wind events.

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Magnetospheric ULF waves, global magnetic field oscillations with periods of a few to several minutes, can effectively transport and energize radiation belt particles through a drift resonant interaction that leads to enhanced radial diffusion. Important parameters governing this transport include the azimuthal mode structure, radial penetration, and azimuthal occurrence of the driving ULF waves. However, the single-point in situ measurements typically available from today's spacecraft don't provide the range of information necessary to quantitatively determine the true effect of ULF waves on radiation belt dynamics. In this effort, we use global, 3d magnetohydrodynamic (MHD) simulations of the sun-Earth system to examine the generation and characteristics of magnetospheric ULF waves that occur during storms driven by high speed solar wind (HSSW) events, commonly observed during the declining phase of the solar cycle. Such storms are associated with sustained enhancements of radiation belt electrons, and often repeat on the 27 day cycle of the solar rotation period. We examine in detail the HSSW event that beganon January 28, 1995, using MHD simulations to characterize ULF wave activity throughout the storm, and suggest diffusive time scales for energetic electrons in the outer zone radiation belts. Results are compared with ULF activity induced by CME-driven storms, and contrasting characteristics of the ULF waves discussed.

Keywords: ulf, radiation, space

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ASIII026 **Oral Presentation** **3571**

Ground- and Satellite-based Measurements of Lightning-induced Electron Precipitation

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Lightning-induced electron precipitation (LEP) effect has been measured with both ground-based methods and also directly on satellites. Ground-based subionospheric VLF methods has evolved to the point where quantitative information on the amount of precipitation induced by single lightning flashes can be estimated, without necessarily having to know the trapped flux distributions. Ground-based observations can also be used to determine the spatial extent of the ionospheric and radiation belt regions that are effected in individual events, and to conduct high resolution measurements of the temporal features of LEP bursts. Of particular importance in terms of the latter is the dependence of the delay from the causative flash of the event onsets, which in principle should exhibit measurable differences in longitude and also between hemispheres. Direct observations of LEP bursts and the causative upgoing 0+ whistlers have recently been realized on the DEMETER spacecraft, providing the unique opportunity to calibrate theoretical models and ground-based measurements. In this paper, we utilize both types of measurements and inter-compare them in an attempt to better quantify the role of the LEP process in the loss of radiation belt electrons. We consider specifically hemispheric differences, and differences in event signatures and detectability with longitude.

Keywords: lightning, radiation belts

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ASIII026 **Poster presentation** **3572**

Energy spectrum and the plateau-like temporal profile of the relativistic electron fluxes at geosynchronous orbit during the storm recovery phase: theoretical interpretation

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The dynamics of relativistic electrons at geosynchronous orbit during the storm of April 6, 2000 is investigated. The data of 0.6 – 6 MeV electrons from Express-A2 and GOES-10 satellites are used. We interpret the results based on the analytical solution of the nonstationary kinetic equation for the relativistic electron distribution function (Bakhareva, 2005). This solution was obtained for stochastic whistler-mode cyclotron resonant acceleration and the losses due to electron escape from the system. The “seed” electron population also is taken into account. We have obtained a good agreement between calculated and observed relativistic electron spectrum and the temporal plateau-like flux profile, both for the energy range 0.6 – 6 MeV.

Keywords: relativistic electron spectra, stochastic acceleration, plateau like flux profile

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ASIII026 **Poster presentation** **3573**

The spatial structure of the coupled Alfven and mirror modes in non-uniform space plasmas

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In an non-uniform space plasmas, Alfven and mirror modes are coupled with each other. This coupling changes dispersion relations of these modes. In particular, the drift mirror mode attains dispersion across magnetic shells (dependence of the frequency on the wave-vector's radial component) which allows to study its structure across magnetic shells. The scale of spatial localization of the wave is shown to be determined by the plasma inhomogeneity scale and by the azimuthal component of the wave vector. The wave propagates across magnetic shells, its amplitude modulated along the radial coordinate by the Gauss function. Coupling with the Alfven mode strongly influences the growth rate of the drift mirror instability. Mirror mode can only exist in a narrow range of parameters. In the general case, the mode represents an Alfven wave modified by plasma inhomogeneity. Due to the coipling, the magneticfield lines oscillate with different frequencies in the radial and azimuthal directions and the Alfven wave frequency depends on the radial wavenumber. Because of its resonance with high-energy particles, the frequency or radial wavenumber acquires a nonzero imaginary part, which vanishes at the Alfven resonance surface. The compressional component of Alfven wave magnetic and electric fields appear.

Keywords: alfven mode, mirror mode, coupling

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ASIII026 **Poster presentation** **3574**

Near-equatorial localization of poloidal Alfven waves in the magnetosphere

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An explanation for the phenomenon of near equatorial localization of poloidal Alfven waves in the dayside magnetosphere is suggested. It is based on the fact that the differential equation for poloidal wave longitudinal structure contains the term which is proportional to plasma pressure and field line curvature. Solution of this equation shows a possibility of a field-aligned resonator for poloidal Alfven waves near the equator in the dayside magnetosphere. Furthermore, in the nightside magnetosphere, similar resonators can appear but localized near the ionosphere.

Keywords: ulf waves, high m waves, resonators

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ASIII026 **Poster presentation** **3575**

Ground-based observations of electron precipitation from radiation belts in the lower ionosphere over Europe

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Lightning-induced electron precipitation (LEP) is a well established loss mechanism of electrons trapped in radiation belts, caused by resonant whistler waveparticle interactions. Groundbased VLF remote sensing yields information on the nighttime ionospheric D region conductivity, altered by the enhanced secondary ionization produced by precipitating energetic electrons. VLF transmitter signals propagate between the surface of the Earth and the lower D region, and due to changes in the conductivity profile along the great circle path (GCP), are being registered with perturbed amplitude and/or phase at the receiver. These perturbations are known as LEP VLF events. The resulting ionospheric disturbances decay away (via recombination and/or attachment) over 10-100 s. Multiple synchronous VLF measurements yield information on the temporal and spatial characteristics of the lightinginduced electron precipitation. There are a number of transmitters all around the world emitting VLF radio waves with very stable phase delay, mainly for navigation and positioning purposes, or as time measuring standards. By means of the receiving system situated in Belgrade it is possible to receive, monitor and store amplitude and phase delay data for six signals on frequencies below 30 kHz. Simultaneous LEP events were recorded on the signals emitted from: Anthorn, (GQD, 22.1 kHz) Main, (NAA, 24 kHz), (HWV, 18.3 kHz) and (IDC, 20.27 kHz). We concentrate on the analysis of ground observations of LEP events recorded during December 2004. By using the numerical program LWPCv21 and by adapting, in successive approximations, the disturbed ionospheric profiles we define the regions of enhanced ionization along the GCP. Comparing geographical locations of enhanced ionization for the four traces mentioned we map LEP events over middle and west Europe. The dependence of observations on geomagnetic conditions and on the geographical longitudes is specifically focused upon. The observations of LEP events provide direct evidence of an important coupling mechanism between terrestrial lightning and relativistic radiation belt electron precipitation.

Keywords: lep events, vlf waves

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ASIII026 **Poster presentation** **3576**

Magnetic Pulsation and Riometer Absorption Signatures During Two Geomagnetic Storms in Late 2006

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Late in 2006 two geomagnetic storms occurred with minimum Dst of -96 nT and -187 nT on November 30 at 14 UT and December 15 at 8 UT, respectively. The occurrences and latitudinal patterns of broadband and narrowband magnetic pulsations in the Pc1-2 frequency band (0.1-5 Hz) at various latitudes in both hemispheres were compared to the signatures of riometer absorption at the same locations for these two storm intervals. We used data from Antarctic search coil magnetometers and riometers located at Halley (-62 MLAT), AGO P2 (-70 MLAT), South Pole (-74 MLAT), and McMurdo (-80 MLAT) and from Northern hemisphere sites Sondrestrom, Greenland (74 MLAT) and the seven-station Finnish chain (57 - 72 MLAT). During the main phase of the December 2006 storm and continuing into the local morning sector of the following day, Pi1-2 broadband noise was the dominant feature at all latitudes in both hemispheres and was accompanied by increased riometer absorption. Narrowband Pc1-2 waves began to occur 5 hours after minimum Dst at the lowest latitude Finnish station and 6 hours after at the higher latitude Finnish stations. The Antarctic stations, located ~5 hours MLT farther west, detected similar Pc1-2 activity 8 hours after minimum Dst. In contrast, during the November 2006 storm Pc1-2 activity occurred 3 hours after minimum Dst at Halley and not until the following day at the Finnish stations and other Antarctic stations. We believe this is a local time effect; during both storms the Pc1-2 activity occurred first at sites which were in the noon-afternoon sector. Both arrays showed continued Pc1-2 activity for 2-3 days after each storm, while broadband ULF noise and riometer absorption diminished.

Keywords: ulf waves, magnetic storms

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ASIII026 **Poster presentation** **3577**

Relationship between Storm-time Pc5 observed at ground stations and MeV Electron Flux at the Geosynchronous orbit

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Relativistic Electron Enhancement (REE) at outer radiation belt during magnetic storms damage satellites in space or lead to terrestrial communication outage. The above phenomenon brings hazards to our life, so we need to clarify the electron acceleration mechanisms of REE during magnetic storms. There are a number of studies for dynamics of radiation belt. ULF waves are believed to contribute to REE. OBrien et al. [2001] found that high solar wind velocity and high recovery phase long-duration Pc5 ULF power are closely associated with the production of relativistic electrons. Other studies also indicate that Pc5 ULF is involved with REE. However, no one has proven with hard evidence (i.e., observational data) the mechanism of how electrons accelerate to relativistic velocities. We compared the data of: (1) magnetic datas of the CPMN (the Circum-pan Pacific Magnetometer Network) and other networks, (2) greater than 2MeV Electron Flux by GOES satellite at the Geosynchronous orbit, and (3) solar wind condition by ACE satellite. We want to clarify whether Pc5 ULF wave can accelerate and heat electrons, and to verify the solar wind characteristic as the generation factor of storm-time Pc5 ULF waves. The detail of our analysis is as follows; (a)The relationship between Pc5 ULF wave and greater than 2MeV Electron Flux at the Geosynchronous orbit (b)The association the storm type (CME,CIR) with greater than 2MeV Electron Flux at the Geosynchronous orbit (c)The relationship between the storm-time Pc5 ULF wave and the solar wind parameters as trigger of it We found that greater than 2MeV Electron Flux is over 104 [/cm2/sec/str] when the amplified Pc5 ULF lasts several tens of hours during the storm recovery phase, regardless of the storm type (CME,CIR). It takes between half-a-day and several days to reach the above threshold value. Additionally, long-duration Alfvenic variation in the solar wind is evident under this condition. We discuss that the storm-time Pc5 ULF associated with long-duration Alfvenic variation in the solar wind accelerates relativistic electrons.

Keywords: ulf, radiation belt

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ASIII026 **Poster presentation** **3578**

Subauroral proton spots visualize the Pc1 source

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Recent observations from the IMAGE spacecraft revealed a new type of proton aurora subauroral proton spots. The proton spots map onto the vicinity of plasmapause. We demonstrate that these proton aurora spots are due to the specific type of the localized energetic proton precipitation that is observed by low-orbiting satellites. This precipitation is closely related to generation of electromagnetic ion-cyclotron waves in the magnetosphere. On the ground these waves are registered as geomagnetic pulsations Pc1. Consideration of simultaneous IMAGE and ground-based data shows that, indeed, when the proton spot is nearly conjugated with the ground station equipped with a pulsation magnetometer, the station always observes Pc1. Moreover, there is a good agreement between appearance/disappearance of the spot and beginning/end of the Pc1 train. We conclude that the subauroral proton spots are images on the ionospheric screen of magnetospheric regions where an intense scattering of the energetic protons into the loss cone occurs due to development of the ion-cyclotron instability.

Keywords: ion cyclotron, waves

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ASIII026 **Poster presentation** **3579**

Efficiency of cyclotron acceleration of radiation belt electrons by whistler-mode waves with varying frequency

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We study the efficiency of the gyroresonant acceleration of radiation-belt electrons trapped by a quasimonochromatic whistler-mode wave packet withvarying frequency, such as chorus element or whistler arising from a lightningdischarge in the Earths atmosphere. For chorus emissions in the Earths magnetosphere, such acceleration regime for which the time-varying frequency of a wave packet is essential can be realized for electrons whose perpendicular energy is higher that that of electrons generating chorus. A specific feature of this regime is its non diffusive nature, i.e., the definite sign of the energy variation depending on the frequency variation in the wave packet. In the case of rising frequency tones typical for chorus elements the energy ofthe electrons trapped by the wave increases due to this interaction. For typical parameters of magnetospheric chorus elements (the wave amplitude Bw ~ 50 pT, the initial frequency omega = 0.3 omegace, and the frequency variation Delta omega = 0.1omegace, where omegace is the electron gyrofrequency), the energy increase during asingle interaction of a trapped electron with the wave packet can reach 10 keV and exceeds by more than an order of magnitude the rms energy variation of untrapped electrons. Estimates show that a significant fraction (tens of percent) of the chorus-element energy can be absorbed during a single hop by electrons accelerated in the trapping regime.

Keywords: radiation belts, cyclotron acceleration, chorus emissions

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ASIII026 **Poster presentation** **3580**

ULF waves in field-aligned current region as observed from INTERBALL-Au satellite

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Case studies of geomagnetic pulsations in the ulf range has been performed in the field aligned current region using magnetometer data onboard Interball-Au satellite from high latitude magnetospheric region. It was seen that electron and proton fluxes in the energy range 0.01-100 keV vary in tandem with the magnetic field perturbation. Particle fluxes are directly observable physical quantity and hence can provide an important diagnostic tool for studying such pulsations.

Keywords: pc5pulsations, particlefluxes, interball au

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ASIII027 **3581 - 3611**

Symposium
Other magnetospheric worlds and planetary ionospheres and thermospheres (ASII014 merged with this symposium)

Convener : Dr. Pontus Brandt
Co-Convener : Dr. Emma Bunce

While the terrestrial magnetosphere shares many common features with planetary magnetospheres, they display enormous variation from the terrestrial system providing a broad range of systems to inform our understanding of the fundamental physics underlying the interactions of magnetized bodies with space plasma environments. Given that planetary magnetospheres can have satellites, rings, dust, and high densities of neutral gas imbedded deep within them, there is much to be gained in asking how processes of transport, auroral generation, and others are maintained in these different environments and which processes are unique only to Earth or to some planets. Our focus will be on lessons learned from remote and in situ investigations of other magnetospheric systems, including in particular Saturn, although results from studies of the Jovian and other systems are most welcome. Papers that draw on the wealth of knowledge of other systems to identify broader themes relevant to astrophysical systems are also welcome as are papers which discuss current knowledge in the context of upcoming missions including the MESSENGER and BepiColombo missions to Mercury, the Pluto/Kuiper Belt Missions among others.

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ASIII027 **Oral Presentation** **3581**

Ring currents at Earth, Jupiter and Saturn: Similarities and differences

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Although the concept of the Earths ring current was proposed by Chapman and Ferraro in the 1930s to explain the decrease in the equatorial magnetic field during geomagnetic storms, its detailed nature in terms of composition and energy content was not determined until the mid-eighties by the AMPTE mission (Krimigis et al, 1985). It was measured in the L-range ~3 to ~5, with most of the pressure in the energy range ~20 to ~300 keV, and to consist of both H+ and O+, with the oxygen accounting for the development and early decay of the storm main phase while H+ persisted for longer time periods. Jupiters ring current was first measured partially by Voyager, with heavier ions (O+, S+) playing a dominant role. Galileos survey (Mauk et al, 2004) showed that it extended from ~ 6 to ~ 20 RJ, the main contribution coming from heavy ions with E > 50 keV and plasma beta in the range ~0.1 to ~ 10. Recent Cassini/MIMI measurements of Saturns ring current (Sergis et al, 2006) revealed a region in the L range ~ 9 to ~ 18, most of the pressure in the range ~ 10 to ~ 200 keV, and consisting of both H+ and O+ ions with the O+ providing most of the pressure during active periods when beta exceeds ~ 1. At all three planets the ring current is maintained by particle injections within the parent magnetosphere. In the case of Earth, ionospheric sources dominate; at Jupiter, Ios volcanoes provide the gas that is subsequently ionized and accelerated; at Saturn the gas is provided by the icy satellites (Enceladus) /rings and ionization and acceleration ensues. It is possible that similar physical processes underlie the formation of the ring current at each planet. A description of the findings at each planet will be presented with emphasis at the latest results from Saturn, and the implications will be discussed in the context of current models. Krimigis et al, Geophys. Res. Lett., 12, 329-332, 1985 Mauk et al, J. Geophys. Res. 109, A09S12, 2004 Sergis et al, Geophys. Res. Lett., (submitted), 2006

Keywords: ring current, magnetosphere, planetary

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ASIII027 **Oral Presentation** **3582**

Solar Wind Magnetospheric Interaction at Mercury

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Mercurys magnetosphere-exosphere-surface system responds to extreme driving forces prevailing at Mercurys orbit (0.31-0.47 AU). Large areas of the Hermean surface are open to solar wind ions precipitating along open fieldlines that map to mid and high latitudes. Production (via ion sputtering) and loss (via photoionization) of neutrals are thus partially regulated by the interaction of the magnetosphere with the solar wind. The variability of exospheric production and loss is systematically affected by long-term variations in the solar wind and interplanetary magnetic field IMF (perihelion to aphelion) and solar wind activity (solar minimum to maximum). In addition, short-term fluctuations are induced by solar energetic particle events or CME events. At such times MHD models predict that the magnetopause is sufficiently close to the planet to allow direct solar wind impact on the surface even around the subsolar point. Photoionization of heavy atmospheric neutrals provides an important population of magnetospheric ions. Such ions may recycle to the surface or escape to the solar wind. The manner and extent to which pickup ions (e.g., O+, Na+, K+, Mg+, etc.) slow magnetospheric convection and affect the large-scale topology of the magnetosphere and related magnetospheric processes is a critical question that will require measurements from MESSENGER and BepiColombo. Test particle and hybrid simulations have revealed the importance of kinetic effects. Short ion residence times expected at Mercury may critically limit their ability to draw free energy from magnetic fluctuations and produce substantial ion cyclotron resonances. The electrodynamics of Mercurys magnetosphere are expected to be equally complex, with magnetic reconnection at the magnetopause and the pick-up of recently ionized exospheric neutrals contributing to field-aligned electric currents. However, these field-aligned currents do not close in an ionosphere. Instead, the Hermean surface likely ties the magnetosphere to the regolith via induction currents. These currents may contribute 10% of the interior field and substantially affect the magnetospheric topology and dynamics, limiting the transfer of magnetic flux from the dayside to the tail.

Keywords: magnetosphere, mercury

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ASIII027 **Oral Presentation** **3583**

Comparative view of transport in magnetospheres.

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Robert Decker, Pontus Brandt, Donald G Mitchell, Barry Mauk, Abigail Rymer, Stamatios Krimigis, Elias Roussos, Geraint Jones, Norbert Krupp

Planetary and satellite magnetospheres all contain populations of trapped charged particles covering the energy range from the cold plasma up to or well above the MeV range. Populations measured by spacecraft represent a balance between losses, sources, and transport. Loss process, such as collisions with satellites, rings, and atmospheres, and charge-exchange with neutral gas, have been extensively modeled as a function of particle species and energy. Less is known quantitatively about transport and the source of very energetic particles. Recent work on injections at both Jupiter and Saturn has revealed that these processes are likely active globally and also represent a way to energize ions and electrons. In this paper, we will review recent work on source processes and transport in the outer planet magnetospheres and Ganymedes magnetosphere. We will develop these ideas using a comparative approach among these various objects.

Keywords: planetary magnetospheres, ganymede, neptune

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ASIII027 **Oral Presentation** **3584**

Thermosphere Responses of the Terrestrial Planets to Solar Variability

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Frank G. Lemoine, Stephen W. Bougher, Sean Bruinsma, Bruce R. Bowman, Alex Konopliv

Contemporaneous observations of thermosphere temperature and density at Earth, Mars and Venus, combined with comprehensive numerical models, offer the opportunity to gain deeper insight into each of these complex systems, and to better constrain quantities such as CO2 cooling, heating efficiency, and thermal conduction. The most recent results pertinent to this problem are based on densities and exosphere temperatures inferred from precise orbit determination of satellites contemporaneously orbiting these terrestrial planets. For instance, in connection with the quasi-27-day variation due to rotation of the Sun, exosphere temperature changes of 20.6K, 7.0K and 2.0K are found for Earth, Mars, and Venus, respectively, per 10-unit change in 10.7-centimeter radio flux (used as a proxy for extreme ultraviolet flux) reaching each planet. The different responses are thought to primarily reflect the differing efficiencies of CO2 cooling in these upper atmospheres, and thus provide an important constraint on planetary atmosphere models that seek to self-consistently and inter-consistently simulate the thermospheres of these planets. In the present work, we augment these results with previously published and recent unpublished data for both long-term (inter-annual) and quasi-27-day solar flux variations, and interpret the whole body of observations within the context of the most recent model simulations. Opportunities for future contemporaneous observations of Earth, Mars and Venus are also outlined.

Keywords: thermosphere, terrestrial planets, solar flux

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ASIII027 **Oral Presentation** **3585**

Dynamics of the thermospheres of the giant planets

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The outstanding problem pertinent to the upper atmospheres of the gas and ice giant planets is: what heats their thermospheres to temperatures far in excess of their stratosphere/mesopause temperatures. The three most promising echanisms are probably gravity wave viscous dissipation, auroral energy deposition, and Joule heating, which both involve dynamics. This talk will review our current understanding of the dynamics and energetics of the thermospheres of the giant planets.

Keywords: thermosphere, giant planets, aeronomy

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ASIII027 **Oral Presentation** **3586**

Interchange motions as the basic process of plasma transport in planetary magnetospheres

Prof. Vytenis Vasyliunas
IAGA

Plasma sources in planetary magnetospheres are found over a wide range of radial distances. The spatial distribution of plasma depends therefore on the transport processes that move plasma from its source regions. Within the region of closed magnetic field lines, motions that displace the plasma must preserve the topology of the field lines. Fundamentally, such interchange motions result from the requirement that magnetic stresses in the magnetosphere be balanced by forces on the planet: when the magnetic stress is not axially symmetric, it can be balanced only by friction between the plasma and the neutral atmosphere, which requires an appropriate flow of plasma relative to the neutral atmosphere (the magnetic stress accelerates the plasma flow until the balancing frictional force is reached). From this point of view, a wide variety of flow processes can be subsumed under a unified description, including magnetospheric convection, ring current shielding, partial corotation, rotationally driven interchange instabilities, and injection events. The role of these processes in the magnetospheres of different planets will be surveyed and critical open questions examined.

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ASIII027 **Oral Presentation** **3587**

Magnetospheric storms at Earth and Saturn

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Space Department The Johns Hopkins University Applied Physics Lab IAGA

D. G. Mitchell, A. Rymer, M. Hill

Terrestrial magnetospheric storms are a well-known phenomenon in whichplasma from the solar wind and the ionosphere is convected into the inner magnetosphere ("ring current") and energized by betatron acceleration and rapid changes in the magnetic field (substorms). Here we compare terrestrial storm characteristics with similar, newly found characteristics of Saturns magnetosphere. We characterize Saturns magnetospheric response to solar wind variability by using remote energetic neutral atom (ENA) measurements with simultaneous in-situ solar wind measurements when Cassini was outside the Saturnian magnetosphere.The Ion and Neutral Camera on board the Cassini spacecraft have obtained global energetic neutral atom (ENA) images of the hot plasma of Saturns magnetosphere since July 2004. INCA obtains ENA images in the 3-200 keV/nuc of protons and O+. The typical observations show hot plasma distributed roughly between 6 to 30 RS orbiting the planet at a period around the 10h45min rotation period depending on energy and species. However, some observations show how ENA intensity builds up on the night side during intervals longer than the rotation period which indicates a gradual source of plasma. The intervals are often ended by a dramatic ENA intensification followed by a rotation of the newly injected plasma around the planet. We have selected a few of such intervals when Cassini was in the solar wind and could obtain solar wind parameters and simultaneous ENA image sequences. We use the Magnetic Field Experiment (MFE), the Cassini Charge Energy Mass Spectrometer (CHEMS), and the Cassini Plasma Spectrometer Subsystem(CAPS) to study the IMF, solar wind speed and density during these events and find that Saturns magnetospheric activity most likely depends more on solar wind pressure than magnetic field orientation.

Keywords: storms, cassini, ena

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ASIII027 **Oral Presentation** **3588**

A system's view of Saturn's dynamical magnetosphere

Dr. Caitriona Jackman
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I will present an overview of dynamics in Saturns magnetosphere, specifically focusing on tail reconnection as the completion of the cycle of energization and circulation of plasma in the kronian system. Dayside reconnection at Saturn is expected to play a role in the addition of flux to the magnetosphere, while the planets rapid rotation and internal sources of plasma also drive dynamics. The relative importance of these factors for triggering magnetotail reconnection will be discussed, while examples of reconnection events in situ will be shown using data from a number of instruments on the Cassini space craft.

Keywords: saturn, reconnection, magnetosphere

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ASIII027 **Oral Presentation** **3589**

Global Plasma Dynamics at Saturn and its Dependence on the Solar Wind

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Bertalan Zieger, Darren L. De Zeeuw, Tamas I. Gombosi

The dynamics and plasma circulation of Saturns magnetosphere are often referred to as lying somewhere on the continuum between the strongly rotationally driven magnetosphere of Jupiter and the solar wind driven magnetosphere of Earth. Cassini and Hubble Space Telescope measurements have demonstrated that to some extent this is true: both the rotation and the solar wind play a role in the magnetosphere, its current systems and it convection patterns. However, as our understanding of the magnetosphere increases, discoveries such as the apparently large plasma source at and near Enceladus have tended to push our understanding of Saturns magnetosphere toward the Jupiter end of the spectrum. In this talk we will explore the global plasma dynamics at Saturn and the relative importance of the internal drivers versus the magnetospheres dependence on the solar wind. Using our 3D global magnetohydrodynamic (MHD) simulation of the magnetosphere of Saturn we have previously found that the magnetosphere may be unstable on a global scale, resulting in periodic releases of plasma that are the main mechanism for large-scale plasma loss from the magnetosphere. This periodic release of plasma is modulated by the solar wind dynamic pressure as well as the tilt of the Kronian dipole axis relative to the Sun-Saturn line. We will quantify these results as they relate to the global circulation of plasma in Saturn magnetosphere.

Keywords: saturn, mhd, plasma

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ASIII027 **Oral Presentation** **3590**

Effects of a rotational force in the ionosphere of Venus and Mars

Dr. Hector Perez-De-Tejada
IAGA

Rotational motion of a planetary ionosphere that interacts with the solar wind may produce a fluid dynamic force (Magnus force) directed transverse to the solar wind velocity and to the rotational vector of the ionosphere. The Magnus force results from a pressure difference that is set across the planet by the difference in the speed of the plasma when both the rotation motion and the solar wind direction are in the same sense to that where both motions are opposite to each other. The retrograde super-rotation motion of the Venus ionosphere may be responsable for the dawnward-directed deflection of the cross-terminator ionospheric flow in the nightside hemisphere and the ~ 15 dawnward offset of the region where most of the ionospheric holes are measured (the latter are interpreted as resulting from plasma channels carved in by the solar wind near and downstream from the magnetic polar regions). The results of a calculation of the Magnus force lead to a dawnward-directed deviation of the cross-terminator flow comparable to that implied from the PVO measurements and are consistent with the difference in the ionopause altitude that is observed between the dusk and the dawn side of the Venus terminator. Similar conditions could be applicable for the Mars ionosphere if the latter follows the prograde atmospheric rotation. If that is the case an ionospheric flow eroded by the solar wind from the magnetic polar regions would be deviated in a direction opposite to that at Venus.

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ASIII027 **Oral Presentation** **3591**

Saturnian Magnetospheric Dynamics: Elucidation of a Camshaft Model

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Periodic modulation of magnetospheric phenomena at Earth and Jupiter results principally from the tilt of the dipole axis relative to the rotation axis. Saturns magnetic field is close to axisymmetric. Its dipole moment is tilted by less than 0.5 from the spin axis, yet the power of radio-frequency emissions, the orientation of the magnetic field, and many properties of the magnetospheric plasma vary at a period close to the period of planetary rotation. Here we examine properties of the periodic magnetic signal detected in the magnetospheric regions inside ~12-15 RS. We show that it is associated with a rotating non-axisymmetric system of field-aligned currents flowing on magnetic shells bounding the region where the signals are seen. There is also rotating plasma flow pattern in each ionosphere associated with the field and currents, which however is oppositely directed in each hemisphere. The currents would develop if the ionospheric conductance in one hemisphere were a function of planetary longitude. On magnetic shells beyond the sheets of field-aligned current the magnetic perturbations generate an effective rotating equatorial dipole moment which when added to the planetary dipole moment produces, in net effect, a dipole moment tilted relative to the spin axis at an angle of order 12-15. The overt source of the north-south asymmetric ionospheric circulation could link to different ionospheric conductances that result from non-uniform solar illumination. Other possible sources are discussed but, although we can elucidate much, the origin of the cam signal as well as other phenomena with the same basic period, such as the Saturn kilometric radio emission, remains enigmatic

Keywords: saturn magnetosphere, periodicty

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ASIII027 **Oral Presentation** **3592**

Recent findings about processes governing the solar wind geospace interaction and their counterparts at Saturn

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Division II IAGA

P. C. Brandt, J. T. Clarke, T. I. Gombosi, K. C. Hansen, M. M. Kuznetsova, A. Ridley

Three emerging aspects of solar wind - geospace interaction that have interesting parallels to Saturn will be explored in this presentation using observations and the results from simulations. These include: (1) response to corotating interaction regions, (2) effect of different solar wind flow regimes on the global configuration, and (3) consequences of non-linear Kelvin-Helmholtz vortices in regions of flow shear. A new understanding of the geospace response to corotating interaction regions (including coupling to the middle atmosphere) has developed from observations during the powerful high speed stream activity in the descending phase of solar cycle 23, which produced the largest yearly auroral energy inputs at Earth in 4 solar cycles. This peak in high-speed stream activity extended through 2003 and into early January 2004. There is a developing awareness of the importance of different solar wind flow regimes (from supersonic to marginal to subsonic) for producing significant changes in the geospace configuration and dynamics. Also, evidence is accumulating that under specific IMF and solar wind flow conditions nonlinear Kelvin-Helmholtz vortices generated by velocity shears at the magnetopause boundary play an important role in transporting plasma into the Earths magnetosphere. Since this plasma is cooler and denser than plasma entering the magnetosphere through the near-Earth neutral line, its presence has far-reaching consequences for the global geospace system response. Potential counterparts at Saturn for each of these terrestrial solar wind-magnetosphere interactions will be explored based on new understanding of Saturns response to solar wind drivers from the Cassini mission and the Hubble Space Telescope, and on comparisons between large-scale simulations of magnetospheric responses to solar wind drivers at Saturn and Earth.

Keywords: comparative magnetospheres, planetary magnetospheres, saturn

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ASIII027 **Oral Presentation** **3593**

Signatures of geo-effective solar flare events in December 2006 recorded close to Venus and Mars

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S. Barabash, M.Dryer, C.D. Fry, Z. Smith, W. Sun, C. S. Deehr, K. Kecskemety, K. Kudela, R. Courtney, R. Lundin, Aspera-3 And -4 Team

A matched suite of analyzers of space plasma and energetic atoms (ASPERA-3 and -4) flown simultaneously aboard ESA's Mars Express (MEX) and Venus Express (VEX) missions are presently measuring plasma particles and energetic atoms close to Mars and Venus. Since the respective orbit insertions in late 2003 and mid 2006 of these spacecraft, solar activity has been in its minimum cyclical phase and, initially, no prominent flares or CMEs were produced. However, a sequence of large geo-effective solar flares occurred in Active Region 0930 during December, 2006. The largest flare (X9.0) began on December 05 at 10:35 UT. ASPERA-3 and -4 were not functioning at this time. However, ASPERA-3 detected an extremely high background level in the ion and electron detectors at Mars (the Mars-Sun-Earth angle was ~150) from 14:00 UT, when the next sequence of spacecraft operations was initiated. These increases lasted for at least 3 days, and are most likely caused by high energy particles emitted by the solar flare. On the other hand, ASPERA-4 flying around Venus did not detect any background increase in particles on December 5. However, an increase in the ambient background of ion and electron detectors were recorded from 08:53UT on December 7 (when the Venus-Sun-Earth angle was ~200 deg). On December 13, another geo-effective solar flare (X 3.4) erupted. The Hakamada-Akasofu-Fry version 2 (HAFv.2) solar wind model predicted that an interplanetary shock generated during this event would arrive at Mars at about 0:00 UT on December 20. The ASPERA-3 ion data show a signature of heating between December 19 (23:45UT) and December 20 (04:00UT), indicating the arrival during that interval at Mars of an interplanetary shock. The arrival time of this shock is in good agreement with the model prediction.

Keywords: solar wind, heliosphere, stereo observations

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ASIII027 **Oral Presentation** **3594**

Recent observations of Saturns and Jupiters FUV aurora with the ACS camera on board the Hubble Space Telescope

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Observations of ultraviolet auroral emissions from Jupiter and Saturn have been obtained since 2005 with the Advanced Camera for Surveys (ACS) on board the Hubble Space Telescope (HST). In particular, an extensive Saturn observation campaign started in January 2007 to take advantage of high-latitude measurements performed by Cassini instruments during a mission phase when the orbit was highly inclined on the ecliptic plane. Earlier observations have shown that the morphology and brightness of Saturns aurora correlate with the solar wind dynamic pressure. Similarly, daily observations of Jupiter, including images from consecutive HST orbits, started in late February in conjunction with the flyby of the New Horizon spacecraft. This was a unique opportunity to correlate the in situ solar wind characteristics and the characteristics of the Jovian UV aurora. It is expected that the main oval is rather insensitive to the solar wind pressure and IMF orientation, while high-latitude emissions inside the main oval appear to respond more directly to solar wind conditions. Previous observations indicated that the brightness variations of the Io footprint on timescales of hours appear to be linked to the position of Io in the plasma torus, while parallel short-term fluctuations in multiple spots have been observed in the south. Short exposures of the multiple spots have been planned to investigate this complex behavior. The campaign observing program will be described and recent results will be presented.

Keywords: jupiter, saturn, aurora

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ASIII027 **Poster presentation** **3595**

Bifurcation of the tail current sheet in Jovian magnetosphere

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Alexander Ershkovich

Multiple crossings of the magnetotail current sheet by a single spaceraft give possibility to distinguish between two types of electric current density distribution: single-peaked (Harris type current layer) and double-peaked (bifurcated current sheet). Magnetic field measurements in Jovian magnetic tail by Voyager-2 and Galileo reveal 14 cases of the magnetotail current sheet bifurcation. Electric current density possesses minimum at the point of Bx-component reversal and two maxima at the distance where the magnetic field strength reaches 50% of its value in the tail lobe. In contrast to the Earths magnetosphere, double peak current sheet is not a common feature of Jovian magnetosphere. It seems plausible, that the occurrence of bifurcated current sheet is determined by the mechanism of its formation. Solution for self-consistent magnetic field in the geomagnetic tail is obtained in a simple model. Magnetic field configuration is created by ion drift current in non-uniform magnetic field. Ion trajectories are such that the electric current density possesses two maxima at both sides of the neutral sheet. Positions of the maxima correspond to the penetration depth of ions into the magnetic field due to finite gyroradius. We arrive at the conclusion that the bifurcated current sheet with two maxima of the electric current density is an equilibrium state of the geomagnetic tail when ion pressure is anisotropic in the plane perpendicular to the magnetic field.

Keywords: magnetosphere, magnetic tail, current sheet

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ASIII027 **Poster presentation** **3596**

1D Hybrid Simulations of Ion Cyclotron Waves Generated by Newborn Ions in Jupiter and Saturn's Magnetospheres

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Jared S. Leisner, Christopher T. Russell, Robert J. Strangeway

At comets, Earth, Venus, Mars, Jupiter and Saturn, spacecraft have observed electromagnetic plasma waves which are believed to originate from newborn ions. When neutral particles in these environments are ionized and picked up into the surrounding plasma, they acquire a non-maxwellian velocity distribution, which is unstable to the generation of waves. At Jupiter and Saturn, newborn ions from the satellites form a highly anisotropic (Tperp > Tpar) velocity space distribution which is unstable to left-hand polarized waves near the gyrofrequency of the newborn ion. These ion cyclotron waves can provide information about the local plasma and pickup conditions. Using a 1D hybrid technique (kinetic ions, fluid electrons), we simulate newborn ion pickup into plasmas like those near the Jovian moon, Io, and the Saturnian moon, Enceladus. Since the wave amplitudes are related to the number of newborn ions generating them, we estimate mass loading rates in the two environments. Previous estimates of the mass loading rates considered the newborn ions to lose 50% of their energy to wave growth, but we find that the value is less. As such, more ions are necessary to generate the observed wave amplitudes, and the mass loading rates must be higher than previously estimated.

Keywords: pickup ions, io, waves

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ASIII027 **Poster presentation** **3597**

The response of Saturn's Magnetosphere to a Northward IMF

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Tatsuki Ogino, Raymond J. Walker

We have used a global magnetohydrodynamic (MHD) simulation is show that the Kronian magnetosphere may frequently contain vortices and turbulent convection that result from the interaction of the solar wind, corotation and magnetospheric convection. This suggests that the Kronian magnetosphere can be very different then either the Jovian or terrestrial magnetospheres. For northward IMF the simulated Kronian magnetosphere reached a quasi-steady state unlike those at the Earth or Jupiter. When the IMF turned northward, dayside reconnection was followed by tail reconnection. It took less than 10 hours for the magnetosphere to reach a quasi-steady state in which the tail neutral line had a U-shape being closest to Saturn near midnight and farther away on the flanks of the tail. Eventually the magnetosphere evolved to a state in which small scale plasmoids were ejected tailward every hour. This sequence of events was independent of the solar wind dynamic pressure or the initial condition of the magnetosphere before the northward IMF turning. On the dayside magnetic reconnection occurred along two neutral lines located north and south of the equator rather than in the equatorial plane. This resulted in a magnetic island forming near the equator. In this presentation we will show the time evolution of the Kronian system with emphasis on the formation of magnetic islands at the dayside magnetopause and the dynamics of the tail reconnection.

Keywords: saturn, magnetosphere, simulation

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ASIII027 **Poster presentation** **3598**

BepiColombo MMO in the context of the Plasma Universe

Prof. Masaki Fujimoto
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BepiColombo MMO is a future mission to Hermean Magnetopshere that will be laucnhed in 2013 and will arrive at the target in 2019. Hermean magnetosphere, because of (1) the small intrinsic magnetic field of the planet, (2) small distance from the Sun, (3) the boundary condition that makes the planet's surface in direct contact with the plasma, and so on, has a unique position in the context of the comparative magnetosphere research. This triggers one's curiosity and motivation to understand Hermean magnetosphere itself. While this is indeed interesting, there is even a larger role that the data from MMO can play. Since the plasma instruments onboard MMO has unprecedented capability (2 sec resolution for particle detector, for example) for a planetary magnetospehre explorer, true comparison between observations at Mercury and at Earth is possible and meaningful. This allows one to step beyond the phenomological argument that the past planetary stuides have been more or less forced to make, and to proceed with a physial model, that is, to understand how a different parameter between the two planets affect the fundamental plasma process that one is looking at. The very basic difference between the two would be in the spatial scale, with the small Hermean magnetosphere likely to be sitting at the edge where an MHD argument is valid. Then, when, again, unprecedented high-quality data from the future Jovian magnetpshere mission (planned to be in 2020's via ESA-JAXA collaboration) will come in, we will be learning the plasma physics in the huge system. Combining the three together, we will be obtaining data-based understanding of space plasmas at three different settings. In other words, the next 20 years will be our golden decades to complete what we can do via in-situ measurements in contributing substantially to our understanding of the Plasma Univserse. The message of this talk is that MMO is an indispensable step on the road towards this goal.

Keywords: bepicolombo, hermean magnetosphere, the plasma universe

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ASIII027 **Poster presentation** **3599**

Modeling the tilted current sheet of Saturn

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Magnetic field data from several orbits in late 2006 show periodic current sheet crossings in which the radial and azimuthal components of the magnetic field reverse sign twice during a spin period of Saturn in a manner similar to the dipole tilt induced motions of the Jovian current sheet. In this presentation, we examine all of the data so far collected by Cassini to catalogue all of the periodic current sheet crossings in the data. We examine parameters like the radial distance, latitude, longitude and local time of the spacecraft to understand under what conditions the current sheet crossings are observed. We present models of Saturns current sheet that can explain the periodicities of the observed magnetic field. Detailed modeling shows that the tilt of the current sheet is quite large, of the order of 10 degrees, a surprising large value considering that the internal field does not show any appreciable tilt. We shall explore different mechanisms that can explain such a large tilt in the current sheet.

Keywords: saturn, current sheet, magnetosphere

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ASIII027 **Poster presentation** **3600**

Improving the Internal Magnetic Field Model of Ganymede by use of 3D MHD Simulations

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Earth and Space Sciences, UCLA IGPP, UCLA IAGA

Margaret G. Kivelson, Krishan K. Khurana, Jon A. Linker

Ganymede, the biggest moon in the solar system, has an intrinsic magnetic field. The internal field is strong enough to form a mini magnetosphere, embedded within Jupiters giant magnetosphere, that interacts with the corotating Jovian plasma. We have run a series of three dimensional resistive MHD simulations to understand the magnetic configuration of Ganymedes magnetosphere using several field and particle data sets from Galileo as boundary conditions. Generally the magnetic field configuration resolved in the MHD simulation has shown satisfying agreement with the Galileo observations for all the close encounters. The magnetopause currents are well resolved in the simulations, such that the sharp rotations in the field orientation are quite consistent with the observations. In these simulations, we have used the internal field model from Kivelson et al. [2002] in which Ganymedes internal dipole field was fitted by using observations from three out of the six close encounters under the assumption that the magnetopause currents contributed a constant magnetic field. We will use the more accurate description of field perturbations of the magnetopause currents extracted from our MHD simulations to refine Ganymedes internal field model and to assess the inductive response.

Keywords: ganymede, internal field, simulation

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ASIII027 **Poster presentation** **3601**

The Magnetic World of Multipolar Paleomagnetospheres During Geomagnetic Polarity Transition Epochs

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Joachim Vogt, Kenneth C. Hansen, Tamas I. Gombosi

The internal magnetic field of our planet was not always dipole-like in the geological past. As has been predicted by geodynamo simulations, and also confirmed by recent paleomagnetic studies, the Earths core field was often dominated by higher-order multipoles during the reversal times of geomagnetic polarity transition epochs. Fabian and Leonhardt (JGR, 2007, in print) used a novel optimization method to derive the variation of the Gauss coefficients up to the order of hexadecupoles during the last and best documented Brunhes-Matuyama reversal on the basis of a number of paleomagnetic records from different lava flows distributed all over the globe. In this paper we present steady-state MHD simulation results of a reconstructed transitional paleomagnetosphere where the internal quadrupolar component was higher than the dipole component at the core-mantle boundary. A characteristic feature of such multipolar paleomagnetospheres is the dramatic diurnal variation even for quiet solar wind conditions. We discuss the diurnal variation of the magnetic topology assuming a constant Parker spiral interplanetary magnetic field. Open field line regions can appear not only at polar regions but also around a so-called magnetic separatrix, where reconnection causes field lines that would normally connect to different magnetic poles from adjacent points on the Earths surface to open to the solar wind. The lesson learned from paleomagnetospheric simulations may be utilized in other multipolar planetary magnetospheres as well.

Keywords: paleomagnetosphere, mhd simulation, geomagnetic polarity reversal

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ASIII027 **Poster presentation** **3602**

Science Operation Concept based on the MDP scheme for BepiColombo/MMO

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M. Fujimoto, T. Takashima, H. Hayakawa, Mmo Science Working Sub-Group

BepiColombo / Mercury Magnetospheric Orbiter (MMO) is and mostly dedicated to the first detailed study of magnetic field, waves, and particle environment of the planet Mercury. Four main scientific targets are set for the MMO spacecraft from the BepiColombo mission objectives. They are expected to significantly advance comparative studies of the magnetic fields and magnetospheres of terrestrial planets: 1) Structure and origin of Mercurys magnetic field, 2) Structure, dynamics, and physical processes in Mercurys magnetosphere, 3) Structure, variation, and origin of Mercurys exosphere, and 4) The inner solar system.The MMO payload selected by JAXA in 2005 consists of 5 instruments / instrument packages, wide-range observational capabilities for charged particles and energetic neutral atoms, magnetic field, electric field / plasma waves / radio waves, dust, and exospheric constituents. MGF (Magnetic Field Investigation) for magnetic field with 2 sub instruments, MPPE (Mercury Plasma Particle Experiment) for plasma and neutral particles with 7 sub instruments, and PWI (Plasma Wave Investigation) for electric field, plasma waves, and radio waves with 7 sub instruments will be provided by large consortia of world-leading scientists and experts from Japan, Europe and other countries. Those payload packages will perform in-situ measurements of particles and fields in the magnetosphere of Mercury and its solar wind environment. MSASI (Mercury Sodium Atmosphere Spectral Imager), an imaging system is also included for the study of the sodium exosphere. MDM (Mercury Dust Monitor) covers the dust information around Mercury and the inner heliosphere. Those scientific payload groups are under unified and coordinated controls of the observational mode and time resolution by MDP (Mission Data Processor) provided by JAXA, in order to fulfil the science objectives of this mission.In this talk, this science operation concept based on the MDP scheme is presented. It is based on the conceptual, scientific, and technological studies in JAXA and MMO colleagues, including the discussions in the MMO Science Operation Working Group, which is a part of the MMO Science Sub Working Group (MMO-SWG).

Keywords: mercury, magnetosphere

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ASIII027 **Poster presentation** **3603**

Plasma / Radio Wave Observation plans for Mercury science: Plasma Wave Investigation (PWI) aboard BepiColombo / MMO

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The BepiColombo MMO (Mercury Magnetospheric Orbiter) spacecraft comprises the plasma and radio wave observation system called Plasma Wave Investigation (PWI). The PWI is designed and developed in collaboration between Japanese and European scientists. Since plasma/radio wave receivers were not installed in the former spacecraft, Mariner 10, which observed the planet Mercury, the PWI onboard the MMO spacecraft will provide the first plasma/radio wave data from Mercury orbit. It will give important information for studies of energy exchange processes in the unique magnetosphere of Mercury characterized by the interaction between the relatively large planet without ionosphere and the solar wind with high dynamic pressure. The PWI consists of 3 sets of receivers (EWO, SORBET, and AM2P), connected to two sets of electric field sensors (MEFISTO and WPT) and two kinds of magnetic field sensors (LF-SC and DB-SC). The PWI will observe both waveforms and frequency spectra in the frequency range from DC to 10 MHz for the electric field and from 0.1 Hz to 640 kHz for the magnetic field. In the present paper, we demonstrate the scientific objectives of plasma/radio wave observation around Mercury and the first electric field / plasma waves / radio waves observations executed around the Mercury.

Keywords: mercury, magnetosphere, waves

ASIII027 **Poster presentation** **3604**

Magnetic field structure of Saturn's dayside magnetosphere and its mapping to the ionosphere: results from ring current modelling

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Ring current modelling in Saturns magnetosphere using Pioneer-11, Voyager, and Cassini data shows that the size and strength of the current system grows with the extension of the magnetosphere, governed by solar wind dynamic pressure. The resulting middle magnetosphere field is quasi-dipolar in form when the magnetosphere is strongly compressed, but extends into a current disk when it is strongly expanded. The region occupied by the ring current corresponds to a fixed shell of field lines that expands and contracts with the system size. It thus maps to a fixed co-latitude range in Saturns ionosphere independent of magnetospheric extension, between ~14.5 and ~20 in the northern hemisphere, and ~16 and ~22 in the southern hemisphere. Comparison with Saturns dayside UV auroras shows that they map to the outer magnetosphere region immediately poleward of the outer boundary of the ring current, and to the vicinity of the open-closed field line boundary.

Keywords: planetarymagnetospheres, ringcurrent, solarwindinteraction

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ASIII027 **Poster presentation** **3605**

Modelling the influence of hermean magnetospheric currents on Bepi-Colombo magnetic field observations

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The planetary orbter of the joint European-Japanes BepiColombo mission, MPO, is expected to reach Mercury in 2019. One of its scientific goals is to measure and determine the nature of Mercurys internally generated magnetic field in order to achieve a better understanding of the Hermean dynamo action. In contrast to the terrestrial situation the magnetosperic current system of Mercury induces an external magnetic field of about the same order of magnitude as the internal field. This inhibits the commonly used Gauss-representation of the magnetic potential. This requires new tools to describe the Hermean field. As a first step, the influence of erroneously assuming a current-free environment along the MPO orbit needs to be estimated. For this purpose, we construct a simple 3D-Chapman-Ferraro current system which takes the thin magnetospheric cavity around Mercury into account. Using the Biot-Savart law the corresponding external magnetic field is determined to which an internal field with assumed Gauss-coefficients is added. Consequently the modelled field is analysed using conventional spheric harmonic analysis. Modelled and assumed Gauss-coefficients will be compared and allow a more quantitaive determination of the errors associated with erroneously assuming current-free conditions. Possible alternative field descriptions, for example a Mie-representation will shortly be discussed as they could provide a robust model for separation of the magnetic potentials resulting in a better analysis tool which is yet to be developed.

Keywords: hermean magnetosphere, magnetic potential, component separation

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ASIII027 **Poster presentation** **3606**

The Ionopause at Mars and Venus

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On the dayside of the terrestrial planets solar EUV radiation ionizes the neutral atmospheres leading to ionospheric layerswith peak densities at altitudes between 70 and 150km abovethe planetary surface. For the non-magnetized planets Mars and Venusthis layer forms the primary obstacle boundary to the solar wind, butmagnetic fields induced by the solar wind flow increase the total plasma pressure above the ionosphere and move theeffective boundary to altitudes above 500km where the magnetic pile-up boundary (MPB) forms. This boundary deflects theflow of solar wind ions and electrons. But the deflection and compressionof the magnetic field leads to a third boundary betweenthe ionosphere and the MPB: the photo-electron boundary (PEB),which is defined by the altitude which can be reachedby ionospheric photo-electrons with energies below 50eV.This boundary defines the top end of the ionosphere andthe dynamics of its location can be used to determine the reaction of the ionospheres to changing solar wind pressure and EUV radiation.This boundary is usually separated from the magnetic pile up boundarywhich can be observed in particle data by a drop in more energetic electronsand protons of solar origin.The ASPERA-3 and ASPERA-4 experiments onboard the EuropeanMars and Venus Express missions allow for the first time to determine the energyspectra of photo-electrons in the energy range 10-100eV with high energyresolution (DeltaE/E = 7%). We use these data to determine the locationof the PEB and the pile up boundary as a function of solar wind ram pressure and solar EUVintensity and discuss the relative importance of ionospheric and magneticpressure for both planets.

Keywords: mars, venus, ionosphere

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ASIII027 **Poster presentation** **3607**

Meteoric metal layers in the Mars atmosphere

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The ablation of interplanetary dust particles entering the Earths atmosphere gives rise to the layers of metallic atoms and ions between 80 and 120 km. The aerobraking region of the Mars atmosphere occurs around 90 km, a similar altitude to the Earths. What happens to the metals such as Na, Fe and Mg that ablate in the Mars atmosphere? Radio occultation observations from Mars Express (Ptzold et al., Science, 2005) show that there is a sporadic third layer of ions between 70 and 110 km, which was attributed to a layer of metallic ions (Fe+ and Mg+). However, there are no observations of the neutral metal layers. In this paper, the features of the Na and Fe layers in the upper mesosphere/lower thermosphere of Mars are predicted by adapting models of these layers in the terrestrial atmosphere. These models contain: a meteoric ablation code with a detailed treatment of sputtering, the thermodynamics of high-temperature melts, evaporation kinetics and impact ionization; and the gas-phase neutral and ion-molecule chemistry of these metals derived from laboratory studies of the pertinent elementary reactions, adapted for a CO2 atmosphere. The layers of atomic Na and Fe are found to be much broader on Mars, although with similar column abundances to the terrestrial layers. In particular, the Na layer appears to be suitable for lidar observations of turbulence in the region between 50 and 100 km. Such observations could by utilized by future spacecraft entering the Mars aerobraking region.

Keywords: sodium layer, iron layer, meteoric ablation

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ASIII027 **Poster presentation** **3608**

Evidence of a second layer in the topside of the ionosphere of Mars

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The Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) aboard ESA's Mars Express space probe has provided nearly two years of measurements of the Martian ionosphere. The data are displayed as an ionogram, which plots the time delay of the received reflections as a function of frequency, color coded for amplitude. An ionospheric echo appears as a trace exhibiting a smooth increase in time delay with frequency, and an intensity at least two orders of magnitude higher than the background. As frequency increases, the trace generally exhibits an abrupt increase in time delay at some frequency, forming a discontinuity in the trace that we call a "cusp." Cusps indicate locations of maximums in the electron density as a function of altitude. Previous analysis of MARSIS data has shown that the main ionospheric layer on the dayside of Mars has a peak electron density of roughly 105 cm-3 at an altitude near 130 km. MARSIS ionograms also commonly show a second cusp at a lower frequency, indicating the presence of another distinct layer higher in the ionosphere. The peak density of this layer is about 5 x 104 cm-3 at an altitude near 200 km. The most probable cause for this feature is a peak in the density of O+ ions, which the Viking landers previously found to peak near 225 km. Other possible causes, including solar wind transport, magnetic field effects, and Kelvin-Helmholz instabilities, are also being studied. Analysis shows this feature to be a normal part of the Martian ionosphere and not due to variations in the solar UV flux. However, this feature does exhibit some dependence on solar interaction, as it is most prevalent at lower solar zenith angles.

Keywords: mars, ionosphere

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ASIII027 **Poster presentation** **3609**

Response of the martian ionosphere to solar stimuli as detected by the MARSIS active ionospheric sounder aboard Mars express

Dr. David D. Morgan
IAGA

D.D. Morgan, D.A. Gurnett, D.L. Kirchner, A.J. Kopf, E. Nielsen, J.J. Plaut, G. Picardi

The Mars Advanced Radar for Subsurface and Ionospheric Sounding, deployed in June of 2005, has by now taken data covering most of the surface of Mars, comprising nearly two thousand usable orbits. Each periapsis pass, during which the sounder is operating, potentially contains over two hundred ionograms. Each such ionogram may exhibit a trace due to reflection of the sounding wave from the topside of the Martian ionosphere. We have developed techniques for converting such traces to profiles of the electron density as a function of the altitude from the Martian surface and have applied these techniques to about 3000 ionospheric traces. In addition, we can compare these profiles to results expected for a photochemical equilibrium (Chapman) layer. These orbits have sampled a wide variation of solar conditions, including F10.7 flux, x-ray background, absolute x-ray and XUV flux, and the presence or absence of solar energetic particles. We can therefore use our data to directly examine the effects of various solar inputs on the global attributes of the Martian ionosphere. We here present results of these analyses. We hope that our results will provide useful input for continued modeling of the Martian ionosphere.

Keywords: mars, ionosphere

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ASIII027 **Poster presentation** **3610**

Low Altitude Characteristics of Ion-Neutral Coupling in Venus Nightside Ionosphere An Examination using Pioneer Venus Orbiter Data

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IAGA

Joseph Grebowsky, Wayne Kasprzak, Walter Hoegy

Archived data, available from Pioneer Venus Orbiter (PVO) covering over a full solar cycle from before the peak of cycle 21 (December 1978) past the peak of cycle22 (October 1992), are used to study the uncoupling of the ionosphere from the neutral atmosphere. The early measurements provide solar maximum observations when there was characteristically a substantial nightside ionosphere. The late mission measurements were made under quiet solar conditions, more comparable to the state of the ionosphere that Venus Express has encountered. Evidence of ionospheric flow is sought by a comparison of the deduced ion densities from the Orbital Ion Mass Spectrometer (which assumed collection at the spacecraft velocity) with the measured electron density from the Orbital Electron Density Probe (which was independent of the ion velocity) and by the limited availability of Orbital Retarding Potential Analyzer Ion Drift Measurements. Measurements made by the Orbital Neutral Mass Spectrometer are also used in the analysis. The evidence for flow at high altitudes is very evident during solar maximum in the comparison of the ion-electron measurements and perhaps at lower altitudes during solar minimum. The influence on the measurements of superthermal ions and impact ionization at low altitudes is discussed. A search was made for the presence of ion flows at low altitudes to determine where the ion dynamics uncoupled from the neutral atmosphere. In the region of strong-ion neutral coupling the neutral composition measurements can show departures from nominal ambient conditions when the ion velocities and densities are sufficient to drag the neutrals. Analysis of the datasets of neutral, ion, and electron densities along with the magnetic field exhibits the correlation between the ions and neutrals on a variety of scales from large-scale behavior to small-scale fluctuations. A simple ion-neutral coupling model is used in the analysis. Comparisons of similar processes expected to occur on another unmagnetized body, Titan, are made using Cassini Plasma Spectrometer (CAPS) measurements along with other related Cassini orbiter data.

Keywords: ion neutral, coupling, venus titan

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ASIII027 **Poster presentation** **3611**

Tracing Sodium in the Exosphere of Mercury

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Pavel Travnicek

Using a particle tracing technique we investigate properties of heavy sodium ions of planetary origin in Mercury's exosphere. We consider basic releasing mechanisms, namely photon stimulated desorption, solar wind sputtering and micro-meteoroid vaporization. We employ 3D hybrid kinetic simulations in order to obtain initial conditions defining the electric and magnetic fields of Mercury'd magnetosphere. Because of high orbit eccentricity of the planet we take into account two extreme conditions of solar wind. We present quantitative comparison of releasing processes importance together with examples of distribution functions and try to localize sources of instabilities by measuring temperature anisotropy throughout the simulation.

Keywords: hybrid simulations, particle tracing, exosphere mercury

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ASIII028 **3612 - 3619**

Symposium
Reporter reviews

Convener : Prof. Masaki Fujimoto

Invited reporter reviews by eminent scientists selected by their peers are presented on the following topics: 1. Large-scale fields, flows and plasma morphology; 2. Magnetospheres of solar system bodies other than Earth; 3. Boundary layer structures and processes; 4. ULF waves; 5. Dynamics of the magnetotail; 6. Multi-scale physics in the auroral acceleration region; 7. Ring current, radiation belts and inner magnetospheric plasmas; 8. Wave-particle interactions.

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ASIII028 **Oral Presentation** **3612**

Wave-particle Interactions Reporter Review

Dr. Christopher Chaston
Space Science Laboratory University of California

In this presentation we attempt to present a unified review of research preformed in the field of wave-particle interactions in the magnetosphere and on its boundaries, and not covered in the other review topics, that has been published in the last two years. Where possible, this talk will be organized according to the wave mode being discussed rather than the region where the waves are observed. To prevent overlap with the ULF review section we will begin with waves observed at frequencies greater than the ion gyro-frequency and finish at the upper hybrid frequency. This will include solitary waves. Special emphasis will be placed on those wave-particle interactions having the greatest geophysical importance including those associated with substorm onset and boundary layer processes.

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ASIII028 **Oral Presentation** **3613**

ULF Waves Reporter Review

Prof. Dong-Hun Lee
Astronomy and Space Science Kyung Hee University IAGA

This review will introduce recent progress in ULF wave studies throughout the magnetosphere. Emphasis will be placed on the excitation mechanism and propagation mode of ULF waves, the interaction of the waves with the magnetospheric energetic particles, and magnetospheric diagnostics using the waves.

Keywords: ulf, wave, micropulsation

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ASIII028 **Oral Presentation** **3614**

Co-ordinated, multi-scale studies of dayside reconnection and the magnetopause boundary layer

Prof. Malcolm Dunlop
Space Science and Technology (SSTD) Rutherford Appleton laboratory IAGA

The present review will summarise the recent work carried out in the context of the magnetopause: its structure, dynamics, behaviour and related phenomena. In this special report topics resolved specifically by the four spacecraft measurements provided by the polar orbiting Cluster spacecraft in coordination with the two Doublestar spacecraft will be summarised. Doublestar provides direct confirmation of FTE evolution by providing measurements elsewhere on the magnetopause.The review will therefore focus on coordinated CLUSTER-Double Star conjunctions which have investigated reconnection associated signatures observed at different locations, both in terms of transient FTEs, arising from opened flux ropes during intermittant reconnection, and comparative boundary layer signatures during cusp and magnetopause transitions, and on the flanks. Comparison can be made between a number of related techniques for combining the 4-spacecraft information to uniquely determine morphology. This provides the context for comparative DSP measurements either in the adjacent high-altitude cusp (TC-2) or at the equatorial magnatopause and LLBL (TC-1). Some attempts have been made to quantify differences in the structure and dynamics of the magnetopause boundary layer between the spacecraft locations. Selected topics include: the issue of whether anti-parallel or component merging dominates dayside reconnection by tracking FTE occurrence and motion; the related issues of whether dayside x-line formation is predominantly located near the sub-solar point and its (local time) extent; properties near the diffusion region during a series of direct reconnection events (for northward IMF and strong By); the composition of the electron BL and its extension from the LLBL into the high latitude and cusp regions; the solar wind control of cusp and MP dynamics and morphology; the processes governing the formation of the cold dense plasma sheet; the generation and role of Kelvin-Helmoltz waves on the flanks and EMIC and mirror waves in the upstream magnetosheath adjacent to the cusp and MP.

Keywords: magnetopause, bounday, reconnection

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ASIII028 **Oral Presentation** **3615**

Dynamics of the magnetotail

Dr. Rumi Nakamura
IWF OeAW IAGA

Recent advances in the research on the dynamics of magnetotail are reviewed particularly highlighting the results on current sheet dynamics and substorm physics. Major contributions come from multi-satellite observations on global and local scales by Cluster and Double Star combined with the ISTP spacecraft fleet. Particularly, Cluster with changing separation between 200 km and 10000 km enabled to study processes at different scales covering particle physics to MHD-scale processes. Advanced methods for analyzing multi-point measurements have been developed and applied to these new observations. Large scale multipoint observations along the radial direction of the tail combined with the ground-based observations and global images provided new insight to the substorm dynamics and magnetotail responses to the enhanced solar wind input. These new sets of observations allowed to stimulate new simulation studies and theoretical studies on local as well as global magnetail processes.

Keywords: magnetotail, substorm, current sheet

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ASIII028 **Oral Presentation** **3616**

Large-scale fields, flows and plasma

Prof. Joachim Raeder
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This reporter review covers large-scale convection in the magnetosphere, the structure of plasma populations in the magnetosphere-ionosphere system; plasma sources, transport and sinks and their dynamics; global aspects and effects of acceleration processes and plasma convection; ionosphere-magnetosphere convective coupling and related current systems.

Keywords: magnetosphere, ionosphere, review

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ASIII028 **Oral Presentation** **3617**

Plasma Coupling in the Inner Magnetosphere

Dr. Jerry Goldstein
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In this review, I present an overview of the past two years of research concerning how inner magnetospheric plasmas are coupled to the Earth's plasmasphere. The dynamics of the plasmasphere have been investigated via various measurement techniques, including ultra-low-frequency (ULF) and very low frequency (VLF) wave sounding, in situ measurements, and total electron content (TEC) from Global Positioning System (GPS) radio signals. Correlations (both spatial and temporal) between outward motion of plasmaspheric plumes and poleward motion of ionospheric TEC enhancements support the idea that the dynamics of these two regions are intimately connected. The fate of plasmaspheric plumes at the magnetopause is a topic of continued interest, and evidence supports the idea that some plasmaspheric material may survive the passage over the polar cap, into the magnetotail. The importance of these details of the global system's behavior are critical for fully understanding the inner magnetosphere. The formation and evolution of the ring current and radiation belts are closely tied to the presence of cold, dense plasma. Significant space weather effects arise from plasmaspheric erosion, including enhancements of the radiation belts and disruption of GPS signals, causing range errors for users on the ground. All lines of research point to a strong inter-region coupling, so that to study any one part of the inner magnetospheric system requires consideration of the system as a whole.

Keywords: plasmasphere, ionosphere, coupling

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ASIII028 **Oral Presentation** **3618**

Magnetospheres of Solar System Bodies Other Than Earth: Research 2005-2007

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Magnetospheres are huge and unique entities in our solar system. They provide unprecedented plasma laboratories to study various physical phenomena such as particle transport, acceleration mechanisms, auroral processes, plasma wave emissions, gas/dust interactions with magnetospheric plasma, magnetotail dynamics, substorm-like processes. The best studied magnetosphere is that of the Earth used as a baseline for the processes observed to compare with those found in all the other known intrinsic magnetospheres and induced magnetospheres (Mars, Venus, and Titan). During the last two years especially Cassini/Huygens to Saturn, ongoing analysis of Galileo to Jupiter as well as the Jupiter flyby of the New Horizon spacecraft on its way to Pluto in combination with new ground-based and Earth-orbit based observations enhanced our knowledge about outer planets magnetospheres dramatically. Results of missions to Mars (Mars Express,) and to Venus (Venus Express) are also quite numerous and gave as a new picture of the vicinity and interaction between the planet and its exospheres/atmospheres. In addition new modeling and simulation work for planetary magnetospheres have been developed which serve as a tool to better understand the in-situ data sets as well as to plan future missions, i.e. to Mercury or further outer planets investigations. This paper summarizes the science highlights in planetary magnetospheric physics obtained since the last IUGG/IAGA meeting in Toulouse 2005.

Keywords: magnetosphere, outer planets, terrestrial planets

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ASIII028 **Oral Presentation** **3619**

The Auroral Acceleration Region The Magnetosphere-Ionosphere Coupling Interface

Dr. Robert Strangeway
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The auroral acceleration region (AAR) provides an interface between the magnetosphere and ionosphere that transfers mass, momentum and energy between the two. The AAR also modifies the means by which this transfer occurs. For example, the AAR is in general dissipative, with electromagnetic energy being converted to mechanical energy, usually in the form of enhanced electron energy. Here we review recent progress in understanding several aspects of the AAR. Topics include the micro-physics of the AAR, the role of the AAR in modifying the coupling between the magnetosphere and ionosphere (meso-scale), and the AAR in a global context (macro-scale). In the context of micro-physics we will discuss the structure of the AAR, with emphasis on the different types of parallel electric field, such as large-scale but weak electric fields in the inverted-V region, double layers that ensure quasi-neutrality, and wave-generated parallel electric fields. We will also discuss wave instabilities associated with the particles accelerated by these fields. In terms of meso-scale processes, we will review how the AAR modifies the ionosphere, and so changes the boundary conditions of the coupling region, as well as other processes that provide a feedback loop between the magnetosphere and ionosphere (e.g., mass coupling). For the macro-scale we will address issues such as the source of field-aligned currents in the magnetosphere and the closure of these currents in the ionosphere and the global response of the AAR to changes in external drivers. Finally, we will discuss future progress in understanding the AAR expected with the launch of the Time History of Events and Macroscale Interactions during Substorms (THEMIS) mission.

Keywords: magnetosphere ionosphere, auroral, acceleration

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ASIV029 **3620 - 3626**

Symposium
The International Geophysical Year and its impact on space science (Division IV and IDCH, Divisions II, III and V)

Convener : Dr. Ed Cliver

The International Geophysical Year (IGY) in 1957-8 ranks among the most significant events in space science history. The IGY witnessed the launch of the first artificial satellites and space probes, 10 in all, beginning famously with Sputnik 1 on 4 October 1957. This session will focus on the role of the IGY in establishing the field of space science, discoveries made during the IGY (most notably the Van Allen belts), and the enduring impact of the IGY on the organization and conduct of space science and exploration. Accounts of IGY space activities, including national organization and planning of IGY space efforts, are solicited.

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ASIV029 **Oral Presentation** **3620**

COSPAR: An Offspring of the IGY

Prof. Gerhard Haerendel
Div IV IDCH IAGA

Soon after the beginning of the IGY, the launch of Sputnik-1had opened the space age. In the political climate of the Cold War it appeared to be most desirable to keep space research out of the political confrontations. Therefore, in late September, early October 1958 the Executive Board of the International Council of Scientific Unions, ICSU, proposed the formation of a Special Committee on Space Research for a trial period of one year. The proposal was subsequently accepted by the General Assembly. A few weeks later, at a meeting in London, convened by Homer Newell on behalf of ICSU, the structure of COSPARs Bureau and Working Groups was essentially designed and Henk van de Hulst became the first president. COSPAR organized its first Space Science Symposium in Nice in January 1960 with 166 participants and 88 papers presented. One year later, at the COSPAR meeting in Florence, the Soviets announced the first man in space, Yuri Gagarin. The lecture will give some insights into the early years of COSPAR, characterized by political problems, successful diplomacy and a strong will to communicate across the iron curtain, thereby slowly evolving into a unique platform of east-west encounters.

Keywords: cospar, igy, icsu

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ASIV029 **Oral Presentation** **3621**

Geodesy, Time and the Markowitz Moon Camera Program

Dr. Steven Dick
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The Space Age ushered in an unprecedented opportunity for precision geodesy. The size and shape of the geoid, previously limited to observations of the direction or intensity of gravity at observation sites, could now be supplemented by the determination of geocentric coordinates from observations of artificial satellites. Such a program was undertaken by he Smithsonian Astrophysical Observatory, with its Moonwatch program combined with the Baker-Nunn cameras. There was, however, a second "geometric method" to determine geocentric coordinates by observing the Moon itself. As Chairman of the Latitude and Longitude Committee of the IGY, astronomer William Markowitz of the U. S. Naval Observatory implemented a program using a dual-rate Moon camera, intended to provide more precise time and geodetic data. What became known as the "Markowitz Moon camera" had originally been designed in 1951 and began operation in 1952 to determine Ephemeris Time, a form of astronomical time based on the orbital motion of the Earth around the Sun. The Moon camera succeeded in 1958 in calibrating atomic time with the Ephemeris second, an achievement of lasting importance on which today's definition of the SI second is based. Meanwhile, some 20 Markowitz Moon cameras were deployed around the world for the IGY geodesy effort. The analysis of the international observations for geodetic purposes proved difficult, and the method was soon superseded by artificial satellites. Nevertheless, the program continued until the mid-1970s to produce Ephemeris Time and the quantity known a "Delta T," the difference between Ephemeris Time and universal time based on the Earth's rotation. Thousands of photographic plates and data sheets from around the world remain housed at the U.S. Naval Observatory. This paper focuses on the successes and shortcomings of the Markowitz Moon camera program, but also places this episode in the context of the history of the determination of time and polar motion (particularly the International Latitude Service), and the relations of these efforts to NASA and the space program. The challenges of this early program makes an interesting contrast to the Smithsonian's better-known Moonwatch/Baker-Nunn program, and highlights NASA's important early role in geodesy with the launch of geodetic satellites like Anna 1B (1962), LAGEOS (1976, 1992) and others. NASA remained very much involved in geodesy with its programs in Satellite Laser Ranging (SLR) and Very Long Baseline Interferometry (VLBI), as well as its use of data from the DoD's Global Positioning System (GPS).

Keywords: geodesy, markowitz, moon

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ASIV029 **Oral Presentation** **3622**

James A. Van Allen and the IGY

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The idea for establishing a program for an International Geophysical Year (IGY) germinated at a dinner organized by James and Abigail Van Allen at their home in Silver Spring, Maryland, on April 5, 1950. Van Allen was still leading the High Altitude Research Group at the Applied Physics Laboratory (APL) of The Johns Hopkins University, where they had instrumented several V-2 rockets in the preceding few years to study cosmic radiation with altitude, among other things. The purpose of the dinner was to enable the visiting Sydney Chapman to meet scientists in the Washington area with similar interests, including Lloyd V. Berkner, J. Wally Joyce, S. Fred Singer, and E. Harry Vestine. Following the dinner, the conversation ranged principally on the ionoshere, geomagnetism, and cosmic rays, whereupon Lloyd Berkner suggested to Sydney Chapman that it might be about time for a Third International Polar Year (the first and second IPY were organized in 1882-83 and 1932-33, respectively). By the end of the evening, the group, with Chapman, Berkner, and Joyce taking the lead, had mapped out a strategy for proceeding with the endeavor. Van Allen was thus an enthusiastic instigator for IGY and a determined enabler and participant during the ensuing years. In this paper, the activities and contributions of the Van Allen group throughout this period will be described, including some of their early observations. They pioneered rocket flights from balloons, among other things, and displayed the inventiveness and innovative spirit that later helped the Iowa group step right into the satellite era and make seminal contributions to todays space science.

Keywords: vanallen, igy, radiationbelts

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ASIV029 **Oral Presentation** **3623**

Satellites, Computers, & Geomagnetism: Enhancing Earth's Magnetic

Dr. Gregory A. Good
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Until the mid-20th century geomagnetic research occurred in two forums: in magnetic observatories or in field surveys. When the Carnegie Institution of Washington's Department of Terrestrial Magnetism undertook a global magnetic survey in 1904, their 'magneticians' traveled by train, mule, canoe, etc., throughout Africa, Asia, South America, and the polar regions, and by sailing ship around the world. The DTM's magnetic 'snap-shot' required 25 years to complete. With new kinds of magnetometers, airplanes, sounding rockets, and ultimately satellites, mid-century scientists had much greater capabilities. Not only could global surveys be conducted much more quickly, but researchers could now target particular research questions, especially regarding the ionosphere and the soon-to-be-named magnetosphere. This presentation relates the stories of the magnetic research program during the International Geophysical Year, the World Magnetic Survey of the 1960s, and several other research programs of the later 20th century with ties to the IGY.

Keywords: geomagnetism, history, igy

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ASIV029 **Oral Presentation** **3624**

John Simpson & the IGY Neutron Monitor Program

Dr. Clifford Lopate
Physics AGU

John A. Simpsons Neutron Monitor Program was one of the great successes of the International Geophysical Year (IGY). Studies of energetic cosmic radiation date from Victor Hess famous balloon flights in 1911-1913 where Hess noted that the flux of radiation increased as he rose higher in his balloon clearly this radiation came from above. Initial studies of cosmic radiation used electroscopes, ionization chambers and emulsions. These methods responded mainly to the mesonic (or hard) component of air showers initiated by cosmic radiation, and thus had response at relatively high energies (≥ 10,000 MeV). Simpson was hoping to build an instrument which responded to the lower energy (≥ 500 MeV) nucleonic component of cosmic ray induced air showers. He based his neutron monitor design on work which he had done on nuclear fission processes while at the University of Chicago during WWII. His neutron monitor design, originally called a neutron "pile" and later to become the IGY-NM, used BF3 gas surrounded by moderating lead to detect secondary neutrons resulting from atmospheric interactions of the primary the cosmic radiation. With his neutron monitor design, observations of the cosmic radiation increased in sensitivity by a factor of ~20 over the older methods. His observations showed detailed time variations of the cosmic radiation that was clearly of geophysical origin. His work, and that of other in the field of astro-particle physics, was at first largely ignored by the majority of the cosmic ray physicists. In fact, cosmic ray studies were not included in the preliminary formulation of investigations in the IGY. According to John Simpson it was the meetings during the 3rd ICRC which were the beginning of the significant influence which cosmic ray research would have on the IGY. In 1953, at Gregor Wentzels invitation, John A. Simpson joined a group of about 20 interested scientists at the 3rd International Cosmic Ray Conference in Bagneres-de-Bigorre, France in discussing the geophysical aspects of cosmic ray observations. By the end of the 3rd ICRC the interest in these geophysical observations had grown to more than 50 people, and was so great that their inclusion in the IGY program was virtually guaranteed. There was particular interest in John Simpsons Neutron Monitor design in association with the standardization of cosmic ray recording equipment a key goal of the IGY. His neutron monitor was also simple and inexpensive to produce and operate. With his energetic input the IGY Neutron Monitor program soon became a world-wide effort and a success for the International Geophysical Year.

Keywords: igy, simpson, neutronmonitor

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ASIV029 **Oral Presentation** **3625**

The IGY and the soviet space program

Dr. Anatoli Petrukovich
Space Plasma Physics Space Research Institute IAGA

Obridko V.N., Raspopov O.M., Zelenyi L.M.

During IGY the wide range of research programs were started in various fields of geophysics. Developmentis space sciences was revolutionary thanks to first space launches in USSR and USA and direct observations of solar wind and magnetosphere. We review early USSR space program, relevant to IGY and comment on some aspects of soviet space geophysics research at that times.

Keywords: history, geophysics

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ASIV029 **Poster presentation** **3626**

The "IGY Gold" History Preservation Program

Dr. Barbara Thompson
NASA GSFC NASA GSFC IAGA

An important part of the 2007 activities will be preserving the history and memory of IGY 1957. The "IGY Gold" History initiative, run by the International Heliophysical Year, has several goals, including 1) identifying and recognizing planners of and participants in the first IGY, 2) preserving memoirs, articles, photographs, and all items of historical significance for the IGY, and 3) spreading awareness of the history of geophysics. To achieve the first goal, the IGY "Gold Club" identifies participants from the first IGY (gold symbolizing the 50th anniversary). "Gold Club" inductees are rewarded with a special "IGY Gold Anniversary" certificate of recognition. This presentation will provide examples of historical artifacts collected so far and will discuss plans for historical recognition activities throughout the 2007-2008 timeframe.

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ASIV030 **3627 - 3670**

Symposium
New results from solar and heliospheric missions

Convener : Dr. Mari Paz Miralles
Co-Convener : Dr. Jorge Sanchez Almeida

Continuous observations of the Sun obtained by ground- and space-based instrumentation have provided detailed information on the solar interior, atmosphere, extended corona and solar wind. These observations offer a unique capability to investigate the physical processes responsible for the dynamic nature of the Sun and the Solar Wind. The symposium invites contributions covering new results from observations from existing missions (e.g., SOHO, TRACE, RHESSI, Ulysses, ACE, Wind, Genesis, Cassini) and new missions (e.g., Solar B, STEREO); theory, and modeling of the different aspects of the Sun, including its interior, atmosphere and wind. This symposium is aimed at stimulating exchange and promoting discussion on the recent developments derived from the observations and the latest research in the field.

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ASIV030 **Oral Presentation** **3627**

NEMO: Novel EIT wave Machine Observing tool for SECCHI/EUVI.

Dr. Olena Podladchikova
Solar Physics IAGA

Automatic solar event recognition and analysis is vital for solar sciences, space weather purposes and automatic data selection from the huge modern data flow. CMEs and flares are the principal objects of automatic investigation and cataloguing. However, in the last decade or so, EUV solar imaging from space have revealed a rich diversity of solar disk events, such as dimmings, global waves, post-eruptive arcades, long duration flares and so on. A part of these phenomena that precede CME are called On-Disk-Eruptions (OnDsE). NEMO (http://sidc/be/nemo) is a code that automatically detect and extract from the EUV solar disk OnDsE events, paying particular attention to the dimmings and the so-called EIT waves. This code is developed in collaboration bewteen Royal Observatory Belgium and Naval Research Laboratory to detect and extract Events with EUVI solar imager of SECCHI/STEREO instrument. We present a summary of automatic OnDsE detections from the previous solar minimum to the present one. The special attention is devoted to the evolution properties of the solar blast waves versus solar cycle condition. EUVI/SECCHI A and B telescopes offer opportunities firstly to analyse systematically a big amount of solar blast waves with a high cadence observations and to understand their 3D structure.

Keywords: sechhi, 3d, waves

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ASIV030 **Oral Presentation** **3628**

First results of the S/Waves experiment on the Stereo mission.

Dr. Milan Maksimovic
LESIA CNRS & Observatoire de Paris IAGA

J.-L. Bougeret, K. Goetz, S.D. Bale, M.L. Kaiser, P.J. Kellogg, M.J. Reiner, B. Cecconi, R.J. Macdowall

We present the first results of the S/Waves investigation on the STEREO Mission. The S/Waves instrument includes a suite of state-of-the-art sub-instruments that provide comprehensive measurements of the three components of the electric field from a fraction of a Hertz up to 16 MHz, plus a single frequency channel near 30 MHz. The instrument has a direction finding or goniopolarimetry capability, used to perform 3-D localization and tracking of streams of energetic electrons and of shock waves associated with Coronal Mass Ejections (CMEs). The scientific objectives include (i) remote observation and measurement of energetic phenomena throughout the 3-D heliosphere that are associated with the CMEs and with solar flare phenomena, and (ii) in-situ measurement of the properties of CMEs, such as their electron density and temperature and the associated plasma waves near 1 Astronomical Unit.

Keywords: s waves, solar flares, plasma waves

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ASIV030 **Oral Presentation** **3629**

From Solar Flares to CIRs: First Results from the STEREO/IMPACT Suite

Prof. Robert F. Wimmer-Schweingruber
Institute for Experimental and Applied Physics, University of Kiel

B. Heber, R. Mueller-Mellin, S. Boettcher, R. Gomez-Herrero, C. T. Steigies, A. Klassen, J.Luhmann, D.Curtis, P.Schroeder, R.A.Mewaldt, E.C.Stone, M.A.Wiedenbeck, T.T.Von Rosenvinge, M.Acuna, C.T.Russell, A.B.Galvin

The twin STEREO spacecraft were launched on October 25, 2006 and have since been inserted into heliocentric orbit and begun scientific operation. The IMPACT is a comprehensive suite of in-situ instruments that, together with the PLASTIC instrument, measure the in-situ interplanetary environment from solar wind plasma to high energy particles and the magnetic field. Inspite of the approaching solar activity minimum, four X-class flares and energetic particle events were observed by the STEREO/IMPACT LET and HET instruments in December 2006. The December 13, 2006 event led to a ground level enhancement observed by neutron monitors worldwide. Three of the particle events led to significant intensity increases of particles up to several 100 MeV/nuc at the location of Ulysses at 70 degrees southern heliographic latitude. As solar activity is again approaching its minimum, the large-scale structure of the heliosphere is beginning to be dominated by corotating interaction regions (CIRs). Two CIRs were observed by STEREO/IMPACT instruments in January 2007 and resulted in significant increases in the count rates in the SEP instruments. With STEREO and ACE and SOHO all observing these CIRs at different locations, we now have a wealth of information available that allows new interpretation of the physics that determine the structure of CIRs at different scales. We will report on these observations and other, forthcoming, events.

Keywords: solar, heliospheric, stereo

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ASIV030 **Oral Presentation** **3630**

The STEREO Science Center

Mr. Michael Kaiser
Goddard Space Flight Center NASA

William T. Thompson

The STEREO Science Center (SSC), at the NASA Goddard Space Flight Center, is the "one-stop shopping" location for STEREO data, observation plans, analysis software, and links to other mission resources. Along with the other data products, a special "Space Weather Beacon" telemetry stream, relayed through an array of antenna partners coordinated by NOAA, provides near-real-time images, and will soon also provide near-real-time radio and in-situ data. Through interaction with the Solar Software library, the SSC also acts as a focal point for software coordination. The SSC is closely integrated with the Virtual Solar Observatory, making data easily accessible to users. Details on access to the SSC will be given and examples of the various types of data available at the SSC will be shown.

Keywords: stereo, data

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ASIV030 **Oral Presentation** **3631**

Faraday rotation observations of flux ropes, MHD waves, and the large scale coronal magnetic field

Dr. Elizabeth Jensen
IAGA

Christopher T. Russell

Using Faraday rotation of spacecraft radio transmissions, we examine the large scale structures of the coronal magnetic field, the flux rope nature of CMEs, and the energy flux of MHD waves. We show that the coronal mass ejections that caused Faraday rotation transients observed by Pioneer and Helios had the magnetic structure of flux ropes. We show that the magnetic field predicted by the potential field source surface model reproduces well the Faraday rotation observations from Cassini. Under special observing conditions, we can also detect magnetohydrodynamic waves. If we assume the waves are always present over 4 pi steradians but can only be detected under particular and rare viewing geometry, we find that they release approximately 2X10^{19} W of power into the heliosphere.

Keywords: cme, mhd waves, pfss

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ASIV030 **Oral Presentation** **3632**

Solar hard X-ray and Gamma-emission measured on board coronas-F Satellite during 2001-2005 years.

Dr. Irina Myagkova
Space Research Devision SINP MSU

Vladimir I. Galkin

One of the prime objectives of the SONG (SOlar Neutrons and Gamma-rays) experiment on board CORONAS-F satellite was to measure solar neutrons, hard X-ray and gamma-emission produced in solar flares, providing important informations about particle acceleration processes at the Sun. The spacecraft CORONAS-F (Complex ORbital Observations in the Near-Earth space of the Activity of the Sun) was launched into a circular orbit with an inclination of 82.5 degrees, initial altitude of about 500 km and a final one of ~ 350 km, on July 31, 2001 and operated until December 12, 2005. The duty cycle for the solar flare emission detection on board CORONAS-F was about 40 percents as a result of its orbit parameters, and some major flares occured in 2001-2005 years were lost. However, 37 flares with gamma-emission with the energy more than 0.5 MeV, more than one hundred HXR-flares with the energy more than 50 keV and three solar neutron events were detected by SONG. It is known that the Sun is the most energetic particle accelerator in the solar system, producing ions of up to tens of GeV and electrons of up to tens of MeV. On the other hand, Coronal Mass Ejections (CMEs) play the important role in the particle acceleration in interplanetary medium. Though a large part of CMEs are associated with flares, their connection is not yet absolutely clear. The comparison of CORONAS-F (SONG) data about flares with HXR and gamma-emission (maximal flux, duration, gamma-emission fluencies) with SEP events and parameters of CMEs is useful for the undertanding of particle acceleration processes in solar atmosphere or/and in the interplanetary medium. This work has been partly supported by grant N 05-02-17487 of the Russian Foundation for Basic Research.

Keywords: flares, acceleration, cme

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ASIV030 **Oral Presentation** **3633**

The SECCHI Experiment on the STEREO Mission

Dr. Russell Howard
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Daniel Moses, Angelos Vourlidas, Simon P Plunkett, Jeffrey S Newmark, Dennis S Socker, Joseph M Davila, O. Chris St. Cyr, William T Thompson, James R Lemen, Jean-Pierre Wuelser, Richard A. Harrison, Christopher J Davis, Nicholas R Waltham, Christopher J E

The Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI) on the NASA Solar Terrestrial Relations Observatory (STEREO) mission is a suite of remote sensing instruments consisting of an extreme ultraviolet (EUV) imager, two white light coronagraphs, and two telescopes that comprise the heliospheric imager. SECCHI will observe coronal mass ejections (CMEs) from their birth at the sun, through the corona and into the heliosphere. A complete instrument suite is being carried on each of the two STEREO spacecraft, which will provide the first sampling of a CME from two vantage points. The spacecraft, launched 25 October 2006, are orbiting the Sun, one Ahead of the Earth and the other Behind, each separating from Earth at about 22 degrees per year. The primary science objectives are focused on understanding the physics of the CME process their initiation, 3D morphology, propagation, interaction with the interplanetary medium and space weather effects. By observing the CME from multiple viewpoints with UV and coronagraphic telescopes and by combining these observations with radio and in-situ observations from the other instruments on STEREO as well as from other satellites and ground based observatories operating at the same time, answers to some of the outstanding questions will be obtained. All of the telescopes are working very well and have been producing spectacular images. The panoramic view of the inner solar system is unprecedented. We will show examples of some of the data and some of the initial results.

Keywords: stereo, cme, corona

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ASIV030 **Oral Presentation** **3634**

Detecting the imprint of heavy ions in the corona with total solar eclipse observations

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Institute for Astronomy University of Hawaii IAGA

Dr. Huw Morgan

Over the past ten years, interest in the behavior of heavy ions in the corona has been re-ignited by ultraviolet observations from SoHO and in situ measurements from Ulysses. Models have been central in establishing the role of heavy ions as a diagnostic tool for the physical processes responsible for defining the characteristic differences between fast and slow streams. By probing the source of the solar wind in the inner corona, we show how recent eclipse observations in the visible and the near infrared, notably in the Fe XI 789.2 nm and Fe XIII 1074.7 nm lines, revealed the imprint of the Fe ions forming these lines, thus providing a new piece to the puzzle. These results point to the importance of implementing such observations with existing or future coronagraphs for the exploration of the physical processes controlling the different source regions of the solar wind.

Keywords: total solar eclipses, solar wind, heavy ions

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ASIV030 **Oral Presentation** **3635**

New results from Hinode-EIS

Prof. Louise Harra
Space and Climate Physics UCL-MSSL IAGA

Hinode was launched in September 2006. There are 3 instruments onboard - the Solar Optical Telescope (SOT), the X-ray telescope (XRT) and the EUV Imaging telescope (EIS). I will focus on results based around the EIS results. These include new results in flows in the corona in active regions outside flaring time, flows and turbulence during flares, and the response in the corona during a coronal mass ejection. I will summarise with explaining how scientists can become more involved with Hinode observing.

Keywords: flares, corona

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ASIV030 **Oral Presentation** **3636**

Realistic numerical simulations as a tool to understand solar physics and observations

Dr. Robert Cameron

Schuessler, M, Voegler, A.

Numerical simulations of the solar photosphere have reached the point where most of the dominant physical processes are now included in a sufficiently accurate way as to allow direct comparison with observations. We will particularly concentrate on cases where convection, radiation and magnetic fields all interact and will show how the simulated structures compare with those actually observed on the Sun. These comparisons are particular important to understanding the observations as the simulations provides the unambiguous 3 dimensional structure which can only be inferred from the observations.

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ASIV030 **Oral Presentation** **3637**

Search for Photospheric Footpoints of Transition Region Loops

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Instituto de Astrofisica de Canarias

Teriaca, Suetterlin, Spadaro, Schuehle, Rutten

Sensitive UV observations show the upper solar atmosphere to consist of a hierarchy of loop structures with different temperatures and extents (e.g. Feldman 2002). These loops fill most of the quiet Sun transition region (TR) images, and their footpoints do not seem to be associated with known traditional magnetic structures. They lie across the network boundaries with the footpoints in the interior of supergranulation cells without magnetic counterpart (Feldman et al. 2001, Warren & Winewarger 2000). The magnetic measurements employed so far do not have enough spatial resolution and sensitivity to reveal magnetic structures in cell interiors, however, it has been known for long that such structures exist (Livingston & Harvey 1975, Smithson 1975, Stenflo 1982, Lin & Rimmele 1999, Sanchez Almeida & Lites 2000). A complex magnetic field pervades the seemingly non-magnetic quiet photosphere. Theoretical arguments suggest that a significant part of such photospheric magnetic field actually reaches TR and coronal heights (Schirjver & Title 2003, Jendersie & Peter 2006), providing natural candidates for the so-far unidentified TR loop footpoints. We present an observational study aimed at identifying such photospheric footpoints. The study requires simultaneous observations of the quiet Sun TR loops and the magnetic fields in cell interiors. We observe CIII 977 A with SOHO/SUMER to trace TR loops (Feldman et al. 1999), whereas the photospheric magnetic fields are identified employing high spatial resolution G band images obtained with the Dutch Open Telescope (DOT). G band bright points (BPs) are proxies for intense kG magnetic concentrations (Muller & Roudier 1984, Berger et al. 1995). We will discuss our simultaneous SOHO/SUMER DOT observations, as well as the preliminary results of the data analysis. Among others, (1) the BPs are associated with TR bright features, but they tend to avoid the brightest parts, (2) the BPs are associated TR downflows as expected from model TR loops (Spadaro et al. 2006), and (3) the BPs avoid locations of large TR line widths, locations often characterized by the presence of explosive events (e.g., Teriaca et al. 2004).

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ASIV030 **Oral Presentation** **3638**

Transition Region Physics with SOHO and TRACE

Dr. Daniele Spadaro
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The most recent space missions devoted to the remote-sensing observations of the outer atmosphere of the Sun have provided a very detailed picture of the plasma structures at temperatures in the 0.2 - 0.8 MK range. These observations have demonstrated that fine-scale magnetic structures are the basic components of the quiet transition region. Moreover, the majority of these small-scale structures change considerably within a period of about 5-10 minutes, in some cases reappering every few hours. Therefore, the emerging picture is that of a highly dynamic upper chromosphere and transition region composed of interacting, continuously evolving magnetic loop structures. Flowsalong these loops are frequent, with lifetimes of the order of 1-2 minutes. All this has stimulated a better understanding of the energetics and dynamics of magnetic loop structures in the transition region and low corona, and in particular of the temporal ad spatial character of the associated plasma heating, a key ingredient in the determination of the physical properties of the solar atmosphere plasma. Time-dependent heating is suggested by the transient nature of the observed fine-scale structures and represents an attractive explanation for the observed line shifts, because it naturally produces dynamic phenomena through chromospheric evaporation and coronal condensations. The purpose of this talk is to review the main contributions given by the coronal instruments on board the SOHO and TRACE spacecraft to the investigation of the physical properties of the solar transition region and to illustratehow thepicture ofthis region has been updated on the basis of the new observational results.

Keywords: sun, tr, euv

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ASIV030 **Oral Presentation** **3639**

The Prevalence of X-ray Jets as Observered by XRT

Dr. Jonathan Cirtain
IAGA

We have observed 232 X-ray Jets during a polar coronal hole observation campaign 8 January - 21 January 2007. Previous articles have reported on these events, but the incidence of jet formation was only known to be a few events per day. We have found that there are in fact an average of several per hour. These jets are approximately 2 x 10^4 -- 2 x 10^5 km wide and routinely > 1 x 10^6$ km long. The jet lifetimes range from ~ 100 secs -- 2500 secs. A large percentage of the jets are associated with a small footpoint flare as reported by Shimojo et al. (1996). We have also observed shrinking loops in four cases.

Keywords: x ray, jets

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ASIV030 **Oral Presentation** **3640**

Modeling the solar wind in the inner heliosphere

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C. N. Arge, L. Meyer, D. Odstrcil

One main effort of the Center for Integrated Space Weather Modeling (CISM) is to develop space weather models for the Sun-Earth chain. Among them is the Solar Wind model that gives a 3 dimensional description of the solar wind structures in the inner heliosphere. It is driven by daily NSO/SOLIS synoptic maps. We employ the Wang-Sheeley-Arge (WSA) algorithm to compute potential field solutions of the solar corona and derive inner boundary conditions for the ideal MHD code ENLIL. It in turn propagates the solar wind structures out to Earth and beyond. With this model we can describe the ambient solar wind at the three locations of the ACE and STEREO space crafts; we are also able to predict the plasma parameters for lead times of 1 to 5 days in 6 hour cadences. We report on validation efforts and prediction performance.

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ASIV030 **Oral Presentation** **3641**

First results from the stereo plasma and suprathermal ion composition investigation

Prof. Antoinette Galvin
EOS and Department of Physics University of New Hampshire IAGA

L. A. Kistler, M. A. Popecki, C. Farrugia, E. Moebius, M. Lee, L. Ellis, K. Simunac, K. Singer, C. Walker, L. M. Blush, B. Klecker, R.F. Wimmer-Schweingruber, B. Thompson, P. Bochsler, P. Wurz, H. Daoudi, C. Giammanco, R. Karrer, A. Opitz, M. Koeten, J. L

Two identical Plasma and Suprathermal Ion Composition (PLASTIC) instruments are now flying on the STEREO A and B observatories, which launched in October 2006. PLASTIC together with the IMPACT suite provides the in-situ measurements for the STEREO mission, while SECCHI provides remote imaging of the solar corona.PLASTIC is a solar wind and heliospheric ion mass spectrometer that utilizes electrostatic deflection, post-acceleration, time-of-flight, energy, and position measurements in the energy-per-charge range of 0.25-80 keV/e. The PLASTIC solar wind sector measures solar wind proton bulk parameters (speed, flow direction, density, kinetic temperature) and provides species identification and relative abundances for helium and the more dominant solar wind minor (Z>2) ions. The suprathermal section of the instrument measures ions accelerated under local shock conditions, pickup ions, and the suprathermal tails of solar wind distributions.During this early part of the STEREO mission, as we approach solar minimum conditions, there have been a series of coronal-hole associated high speed streams and interstream sector boundaries. In this talk we will provide an overview of the initial observations under these conditions and the data products available from the PLASTIC investigation.

Keywords: stereo mission, solar wind, suprathermals

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ASIV030 **Oral Presentation** **3642**

Multi-Instrument Searches for Polar Jets: Characterizing Jet Heating and Cooling

Dr. Mari Paz Miralles
SSP division Harvard-Smithsonian CfA IAGA

Steven R. Cranmer, John C. Raymond, John L. Kohl

We will present the preliminary results obtained with SOHO, in particular UVCS, during the SOHO-TRACE-Hinode coordinated observation campaign (8-21 January 2007) for the north and south polar coronal holes. The emphasis is on identifying and tracing polar jets from the solar surface out into the accelerating solar wind and determining their physical properties as a function of height and time. It is still unclear whether the hot jets resolved by Hinode are the same phenomenon as the cooler jets identified at the last solar minimum by EIT, LASCO, and UVCS. We also aim to clarify the relationship between the episodic jets and the longer-lived polar plumes.

Keywords: solar corona, coronal jets polar plumes, uv spectroscopy

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ASIV030 **Oral Presentation** **3643**

Properties of small-scale solar wind flux ropes and their geomagnetic impact over a solar cycle

Mrs. Megan Cartwright
Earth and Space Sciences University of California, Los Angeles

A new class of flux ropes have been discovered with much smaller time (~ 1 hr) and length scales compared to day-long magnetic clouds. We developed an automated technique that identifies small-scale flux ropes through recognizing strong core fields coincident with bipolar signatures. Using our automatic technique we have analyzed WIND and ACE magnetic field and plasma data for years 1995-2005, 1998-2005 respectively. We identified flux ropes with time-scales of 40 minutes up to 12 hours. The distribution of flux ropes per year peaks in 1996 near solar minimum. The majority of flux ropes had a time-scale of ~1 hour in length. Their solar wind context (i.e. relationship to the HCS, CIRs), plasma properties (i.e. length scales, proton temperature, etc), and geoeffectiveness (i.e. relationship to FTEs, Kp Index, AE Index, etc) are presented.

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ASIV030 **Oral Presentation** **3644**

The Coronal and Interplanetary Propagation of Shocks Driven by CMEs From Remote Radio and In-situ Shock Measurements

Prof. Michael Reiner
NASAGSFC, Code 674 Catholic University & Goddard Space Flight Center IAGA

Michael L. Kaiser

The kinematics of CMEs are well characterized to 32 Rs from height-time measurements from existing space-based and ground-based coronagraphs. Although it is well known that fast CMEs must generally decelerate as they propagate through the interplanetary medium, the interplanetary propagation of CMEs is not well quantified or understood. We have used remote radio sensing of the CME-driven shocks as well as the measured shock speeds at 1 AU, deduced from the Wind observations, to characterize the interplanetary propagation of some 40 fast CMEs that generated type II radio emissions. The statistical analysis of these data have provided new insights into when, where and how fast CMEs decelerate. Our results show that while there are wide variations in the kinematics for the individual CME events, there are some notable statistical correlations between the parameters that characterize the deceleration of these CMEs. For example, we find that there is a power-law correlation between the initial CME speed and the initial CME deceleration and between the initial CME deceleration and the deceleration time. These power-law relationships can be used to derive improved space weather algorithms that predict the propagation times to Earth. We will outline how the remote radio and white-light STEREO observations will be used to directly test these results.

Keywords: coronal mass ejections, solar radio emissions

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ASIV030 **Oral Presentation** **3645**

Investigation of emerging active regions from SOHO

Dr. Alexander Kosovichev
Physics Stanford University

Continuous observations of solar magnetic fields andacoustic oscillations from SOHO during 1996-2007 have provided unique opportunity for investigation of magnetic and subphotospheric properties of emerging active regions during various phases of the 11-year cycle. The results of analysis of more than 500 emerging active regions provide new insight in the basicproperties of emerging magnetic flux, such as flux growth and decay, orientation, subsurface perturbations and flows, and areimportant for understanding the mechanisms of solar magnetic field generation.

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ASIV030 **Oral Presentation** **3646**

Prominence plasma investigations with SOHO/SUMER spectra

Dr. Susanna Parenti
Solar Physics Royal Observatory of Belgium

Jean-Claude Vial

We present results based on the information contained in the EUV atlas of prominence (and Quiet Sun) built from SOHO/SUMER spectral measurements. The atlas covers the range 800 - 1250 , and collects more than 400 spectral lines pertaining to the cool and transition-region plasmas. The high spectral resolution of the SUMER data along with the large number of lines available allow us to derive the plasmas parameters in a large range of temperatures with high accuracy. We focus here on a spectroscopic analysis prominence properties: the electron temperature (from the H I Lyman continuum), the non-thermal velocity, the local density and the emission measure. Some differences between prominence and Quiet Sun properties are discussed.

Keywords: prominence, atlas, uv spectra

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ASIV030 **Oral Presentation** **3647**

Study of CME related phenomena using combined STEREO/EUVI data from both spacecraft

Dr. Luciano Rodriguez
Solar Physics SIDC - Royal Observatory of Belgium IAGA

A. N. Zhukov

The Solar Terrestrial Relations Observatory (STEREO) is a mission consisting of two spacecraft designed to study the three-dimensional (3D) and temporally varying heliosphere using a combination of imaging and in situ experiments mounted on virtually identical spacecraft positioned ahead and behind the Earth in its orbit. SECCHI/EUVI, the extreme ultraviolet imager onboard STEREO will provide full Sun coverage in a similar fashion as SOHO/EIT, but with improved cadence and spatial resolution. The main goal of the STEREO mission is to address the three-dimensional structure of the Sun's corona, with emphasis in the origin and development of coronal mass ejections (CMEs). The present work provides an insight 3D analysis of CME related phenomena in the EUV, such as filaments and post-eruptive arcades. By combining simultaneous images from both spacecraft, information on the 3D configuration of the solar structures can be obtained. The identification of the same feature in both images and the calculation of the displacement between them (parallax) is used to obtain the height of the structures seen in EUV images.

Keywords: sun, cmes, stereo

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ASIV030 **Oral Presentation** **3648**

Advances in High Spatial Resolution Solar Physics due to the SST

Dr. Dan Kiselman
The Institute for Solar Physics The Royal Swedish Academy of Sciences IAGA

Goran Scharmer

The Swedish 1-m Solar Telescope (SST) at the Roque de los Muchacos observatoryon La Palma is a vacuum refractor without central obscuration and with integratedadaptive optics. It saw first light in 2002 and immediately acquired diffraction-limited imaging (0.1 arcsec resolution in blue light), essentially increasingthe spatial resolution in solar optical observations with a factor of two andunveiling hitherto unknown structures in the solar photosphere.Since then, new instrumentation and improved image-restoration techniqueshave allowed imaging with high temporal cadence (better than 1 s), and high-resolution polarimetry.We review recent results, particularly concerning sunspot penumbral structure,small-scale magnetic structures outside spots, and chromospheric dynamics.

Keywords: sunspots, chromosphere, sun

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ASIV030 **Oral Presentation** **3649**

The X-Ray Telescope on Hinode

Dr. Edward Deluca

The X-ray Telescope (XRT) on the Hinode mission provides an unprecedented combination of spatial and temporal resolution in solar coronal studies. The high sensitivity and broad dynamic range of XRT, coupled with the spacecraft's onboard memory capacity and downlink capability permit a broad range of coronal studies over an extended period of time, for targets ranging from quiet Sun to X-flares. We will give an overview of the first results from XRT; information on how to access the Hinode data and information on how to propose joint observations with Hinode.

Keywords: corona, x rays

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ASIV030 **Oral Presentation** **3650**

Radio observations of high-speed solar wind electron parameters near solar minimum: Ulysses 2007 fast latitude scan

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The first orbit of the Ulysses spacecraft gave us the opportunity to analyze for the first time several months of radio data in the stationary and steady state high-speed wind. The fast pole-to-pole transit in 1994-1995 has allowed us to make an accurate in situ diagnostics of the electron plasma parameters in the high-latitude heliosphere near solar minimum, using the thermal noise spectroscopy method on the URAP radio receiver. In particular, we have accurately obtained the radial profile of the electron density and temperature in the fast wind without data selection in contrast to ecliptic observations where different types of winds have to be sorted out. The electron thermal temperature profile behaves between adiabatic and isothermal, in qualitative agreement with a simple kinetic collisionless model. The third pole-to-pole fast latitude scan will occur in 2007-2008 again near solar minimum. The quasi-thermal noise spectroscopy will give unique measurements of the solar wind electron density and thermal temperature, other sensors being off. Preliminary observations of the south pole in early 2007 will be presented and compared to the 3-D structure of the solar wind obtained during the previous solar cycle in 1994-95.

Keywords: fast solar wind, ulysses, electron parameters

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ASIV030 **Oral Presentation** **3651**

Helium, neon, and argon isotopic and elemental composition in Genesis targets

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The Genesis mission returned samples of solar wind for ground-based precise analyses of isotopic and elemental composition. We report data from special target materials, a metallic glass designed to provide depth-dependent variations of solar wind noble gas composition, and carbon on silicon targets which trapped either bulk solar wind or one of the three solar wind regimes sampled by Genesis (low-speed = L, high-speed = H, coronal mass ejections = CME). The isotopic composition of He, Ne, and Ar in the bulk solar wind is in agreement with data from the Apollo Solar Wind Composition Experiment, but the Genesis values are more precise. The depth-dependence of the Ne and Ar isotopic composition and the Ne/Ar ratio is essentially in agreement with predictions by ion-implantation simulations for a uniform solar wind composition over the entire velocity range and also with depth profiles previously measured in lunar samples exposed to the solar wind. This means that a formerly postulated enigmatic high-energy component in lunar samples ("SEP-noble gases") is not required any longer to explain the lunar data. However, very close to the surface of the metallic glass target an isotopically relatively light noble gas component is observed which we tentatively attribute to fractionated current-sheet-related solar wind. Preliminary data indicate slight differences in 3-He/4-He ratios in the various regime targets. The L target is enriched in 3-He by some 2.5% relative to the bulk solar wind, whereas the H target is depleted by about 4% relative to the bulk value. Variations in 20-Ne/22-Ne in these targets are hardly detectable, however. To first order this is consistent with fractionation by inefficient Coulomb drag.

Keywords: genesis mission, solar wind, noble gases

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ASIV030 **Oral Presentation** **3652**

Solar wind bulk properties as seen by STEREO/PLASTIC

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The objective of the Plasma and Suprathermal Ion Composition (PLASTIC) experiment on board the two Solar Terrestrial Relations Observatory (STEREO) spacecraft is to measure in situ the abundance and charge state distributions of various solar wind species as well as their velocity distributions with a high spatial and temporal resolution. The measured solar wind bulk properties agree well with the results of other on-going missions as well as the measured distribution functions with the simulated ones. The high angular and energy resolution results show a complex structure of the solar wind velocity distributions. These features are due to different particle populations and the effect of the interplanetary magnetic field orientation. The paper discusses the results obtained after half a year of operation.

Keywords: stereo, plastic, solar wind

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ASIV030 **Oral Presentation** **3653**

Initial results provided by the IMPACT/STEREO measurements of solar wind electrons, suprathermal electrons and magnetic field

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We present initial results obtained with the solar wind electron spectrometers, the suprathermal electron telescopes and the magnetometers onboard both STEREO spacecraft. An ICME occurring early in December 2006 is studied in details using the electron distribution function characteristics and evolutions. We emphasize also the availability of multipoint measurements with the four spacecraft Wind, ACE, STEREO A and B. This long baseline is used to examine phenomena such as interplanetary shocks. In particular we determine how the waves at low Mach number shocks depend on the angle between the upstream magnetic field and the shock normal.

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ASIV030 **Oral Presentation** **3654**

"Hinode" A New Solar Observatory in Space - Initial Results from Solar Optical Telescope

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Hinode (meaning sunrise in Japanese) was successfully launched onSeptember24 2006. It carries three advanced telescopes (solar opticaltelescope, X-ray telescope, and EUV imaging spectrometer) to observethe generationandtransport of solar magnetic fields, and to simultaneously observethe dissipation part of the solar magnetic fields. In particular,solaropticaltelescope has unprecedented spatial resolution with highpolarimetric accuracy to observe the Sun. Considerable new insightson the solar magnetism is being obtained from the first 4 months ofobservations. Iwillpresent some of these new results mainly from the Solar OpticalTelescope aboard Hinode.

Keywords: observations, solar

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ASIV030 **Oral Presentation** **3655**

STEREO, ACE and Wind Observations of Reconnection X-line Extents and Durations in the Solar Wind

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Multi-spacecraft observations of magnetic reconnection exhausts in the solar wind near Earth have provided direct evidence that the exhausts typically result from quasi-stationary reconnection at continuous and extended X-lines. Thus far reconnection events have been identified where the X-line extended at least 2.5 x 106 km and where reconnection persisted for at least 5 hours. These are only lower limits to X-line extents and reconnection durations, limited by available spacecraft spatial separations in the near-Earth vicinity. Although spacecraft separations typically have been large compared to separations available for studying reconnection in Earth's magnetosphere, they have been small compared to the scale sizes of some current sheets in the solar wind. In order to extend these reconnection exhaust measurements to larger scale sizes and longer times, larger spacecraft separations are required. With the launch of the twin STEREO A and B spacecraft, which now increasingly lead and trail Earth in its orbit about the Sun, respectively, a large and varying range of spacecraft separations has become available for study. We have begun to identify solar wind reconnection exhausts in solar wind data as STEREO A and B drift ever further from the Sun-Earth line. Preliminary analysis reveals that common reconnection exhausts were observed by STEREO A and B and by ACE and Wind (both near L1) in the early phases of the STEREO mission. Here we report initial results of a study of X-line extents and reconnection durations as inferred from measurements by these four spacecraft in the early months of 2007.

Keywords: solar wind, reconnection

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ASIV030 **Oral Presentation** **3656**

Highlights from RHESSI - Diagnostics of Particle Acceleration

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Since its launch on February 5, 2002, the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) has returned high-resolution spectra and high-resolution images of solar flares in the x-ray and gamma-ray range. Its single instrument, an array of germanium detectors behind rotating modulation collimators (RMCs), observes from 3 keV to 17 MeV, covering thermal and nonthermal electron bremsstrahlung from microflares to X-class flares, as well as nuclear line radiation in the largest flares. I will review some of RHESSI's major accomplishments toward understanding particle acceleration in flares, including: imaging spectroscopy that suggests the location of reconnection; relative energetics and locations of accelerated ions and electrons; the surprising discovery of gamma-ray emission from trapped relativistic electrons in the corona; and diagnostics of accelerated ions and the flaring solar atmosphere by nuclear line spectroscopy.

Keywords: particle acceleration, rhessi

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ASIV030 **Poster presentation** **3657**

Coronas-F observations of solar-terrestrial outstanding events in the 23RD solar cycle

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Zhitnik Igor, Kuzin Sergei, Kuznetsov Sergei, Kotov Yurii

A number of outstanding events occurred in the Sun in the second half of solar cycle 23 offering an opportunity to study their effects in geospace. The most intensive solar events that caused powerful response in geospace were the events of November 4, 2001, in October-November 2003, in November 2004, and in January and September 2005. During its active lifetime from July 31, 2001 to December 6, 2005, the CORONAS-F mission recorded those outstanding events as well as the associated effects in the Earth's magnetosphere, such as deformation of the magnetosphere, penetration of particles inside it during strong magnetic storms, and detection of flare-generated gamma radiation and solar neutrons. Some major solar events were observed in the SPIRIT/CORONAS-F experiment under the conditions when similar SOHO/EIT observations were unavailable or difficult to conduct. The report presents the results of observation of outstanding events and their manifestations in geospace obtained with the CORONAS-F onboard complex.

Keywords: solar flares, magnetic storms

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ASIV030 **Poster presentation** **3658**

Do Magnetic Clouds deform?

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IAGA

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We address the evolution of magnetic clouds through Grad-Shafranov reconstruction of ejecta observed at different heliospheric distances and latitudes. Two examples of spacecraft line-ups are considered. The differences of reconstructed MC parameters between subsequent encounters of the same magnetic cloud are expected to show significant evolution effects through kinematic and dynamic effects and the interaction with the surrounding solar wind. Deformation of magnetic cloud structure is discussed in the view of theoretical studies and numerical simulations predicting a latitudinal flattening of the cross-section. Consequences for space weather forecasting and interpretation of STEREO data are examined.

Keywords: magnetic, clouds, grad shafranov

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ASIV030 **Poster presentation** **3659**

Possible mechanism of N-S asymmetry of the Sun processes and main cyclicities of the solar activity

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The mechanism of cyclic inversion changes and variations of natural processes of the Earth (and others planets) have been discussed intensively in the last decade. This mechanism is connected with the free and forced relative translational displacements and small turns of non-spherical shells of the Earth - first of all the core and the mantle - under gravitational attraction of the Moon, the Sun and others celestial bodies (Barkin, 2002). We have been described and studied set of inversion phenomena in geodynamics and geophysics (Barkin, 2005; Barkin, Shuanggen, 2006 and oth.): secular, annual and semiannual variations of gravity and geodetic hights; variations of volcano activity and seismic activity and others. Discovered phenomena have been obtained effective confirmations in space geodesy and gravimetric observations (Shuanggen et al., 2002; Blewitt et al., 2003; Daillet, 2006 and oth.). In first inversion phenomena (contrast tendencies in variations of processes) are observed with respect to the northern and southern hemispheres. A set of geodynamical and geophysical phenomena have obtained the dynamical interpretation and the explanation with the help of this geodynamical model. In particular such complex phenomena, as the Mars bipolarity; a concentration of Venus mountains mainly in one hemisphere; the dichotomy structures of some satellites. But we know that many similar inversion phenomena (or asymmetries) are observed in the Sun processes: change of activity between northern and southern hemispheres; contrast variations in rotation regimes of the N/S hemispheres with the certain cyclicities, variation of parameters of asymmetry in the time, others asymmetric phenomena (Li et al., 2001; Badalyan et al., 2001). We believe that some from mentioned processes can be understood and interpreted from positions of developed model. We believe that this mechanism has universal nature and play important role in geophysical processes on all celestial bodies, including Sun and another's stars (Barkin, 2002). According to the developed model in all mentioned solar processes the gravitational influence of planets and, first of all, the Jupiter and Saturn on non-spherical and eccentric shells of the Sun should play the important dynamic role. The Sun core and its external shell (the convective zone) can play the role of the Earth's core and mantle in considered translational displacements. This mechanism we suggest for explanation of the observed data about variations of Sun diameter (Sun shape) and its activity and their possible correlations. The phenomenon of cyclic inversion of contraction and expansion of the northern and southern hemispheres of the Sun with the main period of the solar activity is predicted. Also small linear trend (or long-periodic variation) of mentioned variations also can be observed. Some preliminary evaluations of parameters of discussed phenomena have been obtained on the base of the known results on the study of the Sun diameter variations (Sveshnikov, 2003 and oth.). We have evaluated that chord of the Sun parallel to its equator with a latitude Q is varying on the low dL=[At+Bsin(w(t-to))]sinQcosQ. Here B=0.150 is given in arc seconds (ars) and A=0.009 is given in ars/yr. to = 1970.0 (yr) is a initial moment of the time. w is the frequency corresponding to period in 11.1 years. Other cyclicities of the solar activity also will be observed in variations of hemispheres shapes. Spectral studies of variations of solar activity for last 250 years have allowed to reveal interannual and decade cyclicities (Kaftan, 2004). We shall result here values of the periods (with errors), the revealed variations, by way of their decrease (values are given in years): 51.8+/-0.5 (50.0); 40.9+/-0.3 (40.0); 33.3; 28.8+/-0.2 (28.5); 24.0+/-0.2 (25.0); 21.3+/-0.1 (22.2); 19.0+/-0.1 (18.2); 17.1+/-0.1 (16.7); 15.2+/-0.1 (15.4); 14.2+/-0.1 (14.3); 13.4+/-0.1 (13.3); 13.1+/-0.1 (12.5); 11.9+/-0.01 (11.8); 11.0+/-0.01 (11.1); 10.6+/-0.01 (10.5); 10.0+/-0.03 (10.0); 9.4+/-0.2 (9.51); 9.2+/-0.1 (9.08); 8.8+/-0.02 (8.70); 8.4+/-0.01 (8.33); 8.1+/-0.1 (7.99); 7.9+/-0.02

(7.69); 7.5+/-0.02 (7.40); 7.1+/-0.01 (7.14); 6.7+/-0.02 (6.67); 6.4+/-0.02 (6.45); 6.2+/-0.2 (6.24); (5.75); 5.5+/-0.01 (5.55); (5.00); 4.8+/-0.01 (4.76); 4.6+/-0.01 (4.54). In parentheses the appropriate values of the periods calculated on one fundamental period To=199.8 yr under formula Tn=To/n (n=4,5,6, ...) are presented. According to developed model to this period there can correspond fundamental oscillation of the system "the core- convective zone" and barycenter of solar system. The orbital period of Jupiter Tj and period To determine the period of the main variation of solar activity in 11.1978 yr. References Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, M.: VINITI, pp. 45-97. In Russian. Badalyan O.G., Obridko V.N., Sykora J. (2001) Solar Physics, V. 199, p. 421. Sveshnikov M.L. (2002) Variations of the solar radius from Mercury transits across the solar disk. Astronomy Letters, V. 28, No 2, pp. 133-139. Li K.J., Yun H.S., Gu X.M. (2001) Hemispheric variation in solar activity. The Astronomical Journal, V. 554, pp. 2115-2117.

Keywords: sun shape changes, n s asymmetry, cyclicities

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ASIV030 **Poster presentation** **3660**

Temperature-Dependent Blueshifts in the Plage Region During the Gradual Phase of the X3.2 Flare on December 13, 2006

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We present HINODE/EIS raster scan observations of plage region taken during the gradual phase of the X3.2 flare developed on December 13, 2006. The plage region is located 200 arcsec eastward from the flare arcade. The spectral observations with multi-wavelength allow us to determine velocities from the Doppler shifts in various temperatures. Strong upflows with motionless plasma are observed in the FeXV line 284.2 A (logT = 6.3) in the plage region. The strong upflows are almost 200 km/sec which is calculated by two component Gaussian fitting. On the other hand, at the transition region temperature (HeII, 256.3 A, logT=4.7), very weak upflows, almost motionless, are observed. Furthermore, we found these upflow velocities clearly depend on the temperature, by comparing the upflow velocities among FeXV, FeXVI, FeXIII, FeXII, FeXI, FeX and FeVIII. The hottest line, FeXV, shows the fastest upflow velocity and the second-highest line, FeXIV, shows the second-highest upflow velocity (130 km/sec). The upflow velocities of other Fe lines also follow the order of temperature. All velocities are below the sound speed, but the dependence of velocities on temperature is similar to the dependence of sound speed on temperature. To complement of global dynamics to EIS data, we use EIT data. In this talk, we discuss the characteristics of the plasma which shows the blue shift in the plage region using Doppler shift, temperature and line width.

Keywords: hinode, eis, blueshift

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ASIV030 **Poster presentation** **3661**

Limb CME geometry using LASCO observations

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In this work it is presented a study of the geometrical shape of CMEs derived from LASCO observations. The relationship between CME radial and expansion speeds is revisited and extended in order to test its validity using a larger range of CME speeds, from 200 to 3600 km/s. A high correlation between these two speeds has been found, indicating that this relation is valid for this range of speeds. Vrad-Vexp ratio from 3 self-similar expanding CME geometrical models are calculated and compared with the empirical results from LASCO observations. The general conclusion was that CMEs with angular sizes bellow 80 degrees are on average best fitted by a self-similar expanding cone with a spherical front of radius equal to the distance between the solar surface and the front of the CME, while CMEs with angular sizes above 80 degrees are on average best fitted by a self-similar expanding structure formed by a cone connected to the half of a sphere of radius equal to the major radius of the cone. These results suggest that on average the shape of CMEs changes with increasing angular size. The results presented in this work will be revisited when stereoscopic observations from STEREO are available.

Keywords: limb cmes, cme radial speed, cme expansion speed

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ASIV030 **Poster presentation** **3662**

CME Initiation Observed in Four Bandpasses of STEREO/EUVI

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Luciano Rodriguez

Coronal Mass Ejections (CMEs) are traditionally observed by white-light coronagraphs. However, ten years of SOHO observations of the solar atmosphere in the EUV have demonstrated that the initiation stage of the most of frontside CMEs can be well seen by SOHO/EIT. Coronal dimmings, EIT waves, prominence/filament eruptions, post-eruption arcades and a variety of limb signatures are the CME counterparts in the EUV. However, the 'CME Watch' data series (one image every 12 minutes) is usually taken only in the Fe XII (195 A bandpass) of SOHO/EIT, with other bandpasses being used every six hours. SECCHI/EUVI telescope onboard both STEREO spacecraft has a higher cadence in all four bandpasses (Fe XII 195 A, Fe IX/X 171 A, Fe XV 284 A and He II 304 A). This allows us to study the CME signatures at different temperatures nearly simultaneously. We report on a comparison of CME counterparts observed by STEREO/EUVI with those seen by SOHO/EIT.

Keywords: coronal mass ejections, stereo

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ASIV030 **Poster presentation** **3663**

Evolution of a coronal hole-associated neutral solar wind up to the Solar Orbiter position

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The phase-space distributions of neutral hydrogen atoms are indicative of the behaviour of the main solar wind component formed by protons out to at least 5 solar radii, because the neutral and ionized components are coupled through charge exchange. In fact, beyond this distance the characteristic time for charge exchange between hydrogen atoms and protons becomes comparable to the coronal expansion time scale causing the neutrals to decouple from the charged solar wind. However, the mean free path of the neutral component rapidly increases with the radial distance so that neutrals generated at a given heliocentric distance fly unperturbed and are detected by Solar Orbiter if their mean free path is long enough to let them reach the detector.In addition, more information on the flux origin can be obtained evaluating the differential flux as a function of heliocentric distance that is closely linked to the observation point. At approximately 48 solar radii, the bulk of the flux detected mainly comes from about 9 solar radii. Beyond this distance, the proton velocity distribution is frozen within the generated neutrals and transferred up to the observation position so that neutrals retain information on the three-dimensional distribution of hydrogen at the level where they are generated. In the present study, we report our preliminary results from numerical simulations of the neutral solar wind distribution as predicted at the Solar Orbiter Position. The major parameters of a coronal holeemerging solar wind are estimated by the SOHO UVCS experiment. We then compare the neutral solar wind distribution to thatof theionized component.

Keywords: solar wind, neutral hydrogen distribution, charge exchange

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ASIV030 **Poster presentation** **3664**

Multiresolution Analysis of Synoptic Solar Magnetic Fields

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Magnus Wik, Peter Wintoft

Solar synoptic maps provide an important visualization of global patterns. Maps are available of sub-surface flows, photospheric and coronal magnetic fields. We have carried out a multiresolution analysis (MRA) of longitudinally averaged synoptic magnetograms. The magnetograms were observed at Wilcox Solar Observatory, Stanford and with Michelson Doppler Imager (MDI) onboard SOHO of ESA/NASA. Asymmetric solar magnetic activity, trends, and activity at different scales are described. Predictions, based on neural networks, of solar magnetic activity at different scales are also discussed. With the launch of Solar Dynamics Observatory (SDO), real-time synoptic maps will be available. That would be of great importance for real-time predictions of space weather effects.

Keywords: multiresolution analysis, solar magnetic fields, wso soho sdo

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ASIV030 **Poster presentation** **3665**

Are there systematic hemispherical or longitudinal asymmetries in Coronal Mass Ejections?

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Kalevi Mursula

A considerable amount of evidence has accumulated in support of the existence of persistent, systematic north-south (hemispherical) and longitudinal (active longitudes) asymmetries in the Sun. These features have been observed, e.g., in sunspots, solar flares, solar wind and the heliospheric magnetic field. In this work we analyze the occurrence of coronal mass ejections (CMEs) observed, in particular, by the SOHO LASCO instrument during the solar cycle 23. We discuss the temporal evolution of the occurrence rate of CMEs and study the north-south and east-west asymmetries and their temporal change. We discuss the observations in view of the earlier evidence for hemispherical asymmetries and active longitudes.

Keywords: coronal mass ejections, hemispherical asymmetry, active longitudes

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ASIV030 **Poster presentation** **3666**

On step-like changes in the out-of-plane magnetic field confined to solar wind reconnection exhausts

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John T. Gosling, Dietmar Krauss-Varban

Quasi-stationary magnetic reconnection occurs relatively frequently in the solar wind as recently demonstrated over a large range (0.3 - 5.4 AU) of heliocentric distances by the Helios, ACE, Wind, STEREO, and Ulysses s/c. Evidence of Petschek-type exhausts consists of roughly Alfvenic accelerated plasma flow commonly confined between two separate boundary layer currents that separate the exhaust from two regions of typically asymmetric plasma density, temperature, flow shear, and/or field strength. The changes in the velocity and the magnetic field are anticorrelated at one boundary and correlated at the other in agreement with pairs of Alfvenic disturbances propagating in opposite directions along reconnected field lines. The magnetic field rotation at the two boundary layer currents is observed to occur in a plane perpendicular to the normal direction (Bn) of the initial current sheet. A survey of ACE reconnection events during the 1997-2006 period indicates that the out-of-plane magnetic field component (Bm) frequently experiences a step-like change confined to the exhaust region. We examine the consequences of tangential plasma shear flow in the solar wind frame and the effects of asymmetric conditions on the formation of such magnetic field rotation structures using ACE observations and hybrid simulations.

Keywords: magnetic reconnection, solar wind

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ASIV030 **Poster presentation** **3667**

Consequences of the forcefree model of magnetic clouds for their heliospheric evolution

Mr. Martin Leitner

C. J. Farrugia, C. Mstl, K. W. Ogilvie, A. Galvin, R. W. Schwenn, H. K. Biernat

We examine the implications of the widely-used, force-free, constant-alpha flux rope model of interplanetary magnetic clouds for the evolution of these mesoscale (fraction 1 AU) structures in the heliosphere, with special emphasis on the inner (rh < 1 AU) heliosphere. We employ primarily events observed by the Helios 1 and 2 probes between 0.3 and 1 AU in theascending and maximum phases of solar cycle 21, and by WIND at 1 AU in a similar phase of solar activity cycle. We supplement these data by observations from other spacecraft (e.g. Voyagers 1, 2; Pioneers 10, 11, and others). Our dataset consists of 130 events. We explore three different approaches.In the first, we work with ensemble averages, binning the results into radial segments of width 0.1 AU in the range 0.3< rh< 1 AU. Doing this, we find that in the inner heliosphere the modeled average central axial field strength, B0, varies with heliospheric distance rh as B0 [nT] = 18.1 rh-1.64 and the average diameter increases quasi-linearly as D [AU] = 0.23rh1.14. The orientation of the axis of the underlying magnetic flux tube in our data set is generally found to lie along the east-west direction and in the ecliptic plane at all values of rh, but there is considerable scatter about these average directions. In the second, we monitor the evolution of magnetic clouds in snapshot fashion, using seven spacecraft alignments. The results are in broad agreement with the statistics reported under step 1. In the final approach, we obtain the functional dependence of B0 and D predicted by an analytic expression for a freely-expanding Lundquist flux tube. We find D to vary linearly with rh, broadly similar to that obtained under approach 1. The maximum field strength scales as rh-2 compared to a rh-1.3 dependence obtained from statistics. We compare our findings with those of Bothmer and Schwenn (1998), who used a different methodology. The results obtained form a good background to the forthcoming STEREO and SENTINELS missions and to multi-spacecraft studies of magnetic clouds.

Keywords: magnetic, clouds, evolution

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ASIV030 **Poster presentation** **3668**

Helium distribution and heavy ion composition in solar wind. First results from PLASTIC instrument onboard STEREO.

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PLASTIC (PLAsma and SupraThermal Ion Composition) is the primary instrument for in situ solar wind ion measurement on board the STEREO (Solar Terrestrial Relations Observatory) mission, which was launched in October 2006. For the first time it is possible to measure protons and minor ions simultaneously with the same detector using three different apertures.With the approach of solar minimum we find slow solar wind as well as coronal-hole associated high speed streams. This paper focuses on the three-dimensional helium velocity distributions and on composition measurements for different solar wind conditions during this early part of the STEREO mission.

Keywords: solar wind, elemental composition, helium hydrogen

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ASIV030 **Poster presentation** **3669**

Dynamical Models of the Solar Activity Cycle and Data Assimilation

Dr. Irina Kitiashvili
Astronomy

Modeling and prediction of parameters of the 11-year solar cycles isone the most interesting problems of solar physics, in whichhelioseismology observations play an important role. However, theknowledge of the underlying processes is incomplete, and this makespredictions of the solar cycles difficult. The data assimilationapproach developed in meteorology and Earth science makes possibleefficient and accurate estimations of physical properties, whichcannot be observed directly. In a first approximation, the solardynamo models can be described in terms of simple, Lorenz-type,dynamical systems. The application of data assimilation to this typeof models and the initial results are discussed in this presentation.

Keywords: helioseismology

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ASIV030 **Poster presentation** **3670**

The observation of Gamma-ray emission during January 20 2005 solar flare

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Arkhangelsky A.I, Glyanenko A.S., Kotov Yu. D., Kuznetsov S.N.

The solar flare of 20.01.2005 (class X7.1) was the biggest one in January 2005. It was started at 06:36 UT by GOES data, ended at 07:26 UT and the maximum of X-ray emission was at 07:01 UT. AVS-F apparatus (CORONAS-F) registered gamma-ray emission during rising phase of this flare in two energy bands: 0.1-20 MeV and 2-140 MeV. The highest gamma-ray energy was registered during this flare was 137 pm4 MeV. Some spectral peculiarity was observed in the region of 19.5-21 MeV in 2-140 MeV energy band on 2.5 standard deviation level at 06:44:52-06:51:16 UT. The possibilities of this feature interpretation as previously not observed in solar flares spectra gamma-line 20.58 MeV from neutron capture radiation on 3He are discussed.

Keywords: solar flare, gamma rays, neutrons

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ASIV031 **3671 - 3701**

Symposium
From micro- to macro-scales in the heliosphere and magnetospheres (Divisions IV, II, and III)

Convener : Prof. Gary Zank

Both the interplanetary medium and planetary magnetospheres are characterized by a multi-plicity of scales, ranging from short-scale, high-frequency fluctuations to low-frequency MHD scales to solar rotation and solar cycle scales. The interaction of these scales is often highly non-linear and the separation of scales and physical effects is frequently not obvious. Obvious examples include the scattering and transport of energetic particles by low-frequency turbulence, the interaction of the solar wind with the local interstellar medium, the accelera-tion and transport of solar energetic particles, the evolution and dynamics of turbulence in the interplanetary medium, emission processes at shocks, the response of shocks to turbulence, the characteristics of collisionless shock waves and foreshocks, turbulence in the magnetotail, etc. This session solicits contributions that explore the coupling of multiple scales and physical processes in the context of the interplanetary medium and planetary magnetospheres.

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ASIV031 **Oral Presentation** **3671**

Non-linear and non-local couplings between different space-time scales in dynamics and diagnostics of solar and heliospheric processes

Prof. Igor Veselovsky
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Review will be presented of non-linear and non-local couplings between different space-time scales in solar and heliospheric processes. Two aspects of the multi-scale nature of solar and heliospheric phenomena are the main focus: 1) plasma and electromagnetic field dynamics (theory); 2) couplings as information and diagnostics tools (observations). Dimensionless scaling analysis of dissipative MHD with radiation and plasma kinetic formulations will be outlined in a systematic and complete way based on recent studies. Examples will be presented of known and possible direct and inverse cascades in the energy, momentum and mass transports on the Sun and in the heliosphere. Global heliospheric electric current system consists of many interrelated convective and wave-like structures of broad space-time scales and amplitudes. Self-consistent current sheets, magnetic flux ropes and propagating shocks are among non-linear structures. Solar wind origin and coronal heating problems are discussed as a part of the general self-organization in the open physical system with big free energy, momentum and mass flows. Coronal mass ejections and solar flares considered in unified manner as results of non-local subphotospheric drivers and local instabilities in the solar atmosphere. Laminar and turbulent situations will be considered in the distant heliosphere. They are related to the interpretation of recent Voyager data. Non-linear couplings between large and small scales can be used as markers and signatures of non-fully developed turbulent regimes for evaluation of visible and hidden correlations. Emerging active regions and activated prominences with changing substructures can serve as indicators of eruption probabilities. The work was supported by the grants RFBR 04-02-16736, 06-05-64500 and INTAS 03-51-6202. It is fulfilled also as a part of the Innovative Program of the Moscow State University and Programs of the Russian Academy of Sciences ''Origin and evolution of stars and galaxies'', P16 and OFN16. References I .S. Veselovsky. Dimensionless scaling approaches to the solar and heliospheric processes. JASR 2007 (accepted).

Keywords: sun heliosphere

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ASIV031 **Oral Presentation** **3672**

Multi-Spacecraft Measurement of Anisotropic Correlation Functions In Solar Wind Turbulence

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T. S. Horbury

Magnetohydrodynamic (MHD) turbulence is ubiquitous in high Reynolds number plasmas and affects many astrophysical phenomena - such as the propagation and acceleration of cosmic rays, solar wind heating, and transport of angular momentum in accretion disks - and yet its 3-dimensional structure is poorly understood. Presented is an analysis of MHD turbulence without some of the assumptions and restrictions associated with previous analysis methods and techniques. Eight 40-60 minute intervals of multi-point magnetic field data from the four Cluster spacecraft in the solar wind are used to determine the field-aligned anisotropy of MHD inertial range turbulence. Time-lagged two-point correlations are used to construct a spatial auto-correlation function in order to measure the ratio of the parallel to perpendicular correlation lengths. This is done in conjunction with an elliptical scaling model. The mean ratio obtained, 1.79 +/- 0.36, is significantly greater than unity and therefore consistent with solar wind fluctuations being anisotropic with energy predominantly in wave-vectors perpendicular to the large scale mean magnetic field. The same analysis is also presented using a simulated turbulent field model and comparisons are made with the results obtained using the elliptical scaling model.

Keywords: turbulence, anisotropy, solar wind

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ASIV031 **Oral Presentation** **3673**

Energy versus alfvenic correlation in polar wind fluctuations

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Roberto Bruno, Giuseppe Consolini

Past analyses have shown that the polar solar wind variability at MHD scales appears as a mixture of Alfvenic fluctuations and variations with an energy imbalance in favour of the magnetic term. In the present study, by separately examining the behaviour of kinetic and magnetic energies versus the Alfvenic correlation level, we unambiguously confirm that the second population is essentially related to a large increase of the magnetic energy with respect to that of the Alfvenic population. The relevant new result is that this magnetic population, though of secondary importance in terms of occurrence frequency, corresponds to a primary peak in the distribution of total energy. The fact that this holds for the polar solar wind, namely the least structured type of interplanetary plasma flow with the slowest evolving Alfvenic turbulence, suggests that for all kinds of solar wind regime the magnetic structures cannot be neglected when modeling MHD fluctuations.

Keywords: solar wind, mhd turbulence

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ASIV031 **Oral Presentation** **3674**

Scattering of Suprathermal Electrons in the Solar Wind: Particle-in-Cell Simulations

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Shinji Saito

Properties of the narrow, magnetic-field-aligned strahl electron velocity distributions are sensitive indicators of collisionless processes in the solar wind. At least three distinct signatures have been observed in the characteristics of this suprathermal (70 eV < 1 keV) component: 1) Pitch-angle widths that decrease with increasing energy, 2) Pitch-angle widths that increase with increasing energy, and 3) Pitch-angle widths that have a distinct maximum as a function of energy. This presentation describes results from particle-in-cell simulations which have used three different sources of enhanced fluctuations to demonstrate how each of these signatures can arise. Signature 1) is well-known as being due to scattering by Coulomb collisions, but the simulations have shown that it may also arise as a consequence of scattering by the whistler anisotropy instability driven by a T_perp/T_|| > 1 condition on the electron core component. Signature 2) has been shown by quasilinear theory to arise due to scattering by a broadband spectrum of whistler fluctuations; our simulations confirm that conclusion. Signature 3) arises from scattering due to the electrostatic electron/electron instability. The simulations demonstrate how the latter two signatures change with various plasma parameters.

Keywords: solar wind, electron strahl, scatteriing

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ASIV031 **Oral Presentation** **3675**

MHD turbulence in the solar wind

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Raffaella D'Amicis, Bruno Bavassano, Luca Sorriso-Valvo, Vincenzo Carbone

About four decades ago Mariner 2 provided the first evidence of a turbulence spectrum in the solar wind. Since then, an impressive amount of in-situ observations at different solar distances and latitudes allowed us to reach a good understanding on many aspects of the complex phenomenon of solar wind turbulence. As a matter of fact, we now have a rather complete phenomenological description of the behavior of high-amplitude low-frequency fluctuations of the fields that describe the plasma state of the wind during its expansion. These observations have been a sort of benchmark to test results obtained from numerical simulations, performed within the realm of magnetohydrodynamic turbulence theory, dedicated to unravel what kind of physical mechanisms are at the basis of turbulence generation and energy transfer across the spectral domain of the fluctuations. This presentation aims to provide a brief overview of the main aspects of the phenomenology associated to MHD turbulence in the solar wind and will recall some of the results and predictions obtained from theoretical models and numerical simulations.

Keywords: solar wind, mhd turbulence, nonlinear processes

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ASIV031 **Oral Presentation** **3676**

Non linear structures in the solar wind and heliosheath

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A Magnetic Hole is a stationary stable structure with a small scale depression of the magnetic field in the centre. Such structures were first observed in the inter-planetary magnetic field by Turner et al. [1977] and later from the magnetosheaths of other planets. Recent magnetometer data from Voyager 1 has revealed the presence of a rich class of stationary magnetic structures e.g. magnetic holes, sinusoids, magnetic humps with magnetic field maxima in the centre, trains of several holes and humps, and sequences of merged holes and humps etc [Burlaga et al., 2006]. These structures which are strongly nonlinear have a width of few tens of gyroradii and propagate at oblique angles to the mean magnetic field. In the talk we will review recent observations and data from Voyager and solar wind regarding these structures. We will also give a brief over view of some recent theories to explain the existence of these structures. In particular we will discuss our recently proposed model based on the fully nonlinear theory of solitary wave solutions of McKenzie et al suitably modified for the conditions of solar wind and heliosheath. These solutions i.e., magnetic holes, humps, trains of holes and humps, are strongly nonlinear, propagate at large angles (> 60) to the mean magnetic field and are well approximated by Gaussians. The structures are almost pressure balanced with an anti-correlation between the magnetic field and the plasma density, and no change in the magnetic vector across the structure. These features are consistent with observations of magnetic structures in the heliosheath and solar wind. Results from 1D fluid simulation will also be presented.

Keywords: magneticholes, solarwind, heliosheath

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ASIV031 **Oral Presentation** **3677**

Response of the Termination Shock to Interplanetary Disturbances and V1/2 Observations

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Gary P. Zank, Qiang Hu, Takashi Tanaka

The Voyager 1 (V1) and Voyager 2 (V2) magnetometers and the V2 plasma detectors are still working after their long journey lasting over 3 decades. These observations, in addition to the special event that V1 crossed the termination shock (TS), provide useful information about the outer heliosphere. We are now in a position to study realistically how outer heliosphere has been evolving. This report is focused on modeling the time-varying heliosphere on the basis of a three-dimensional MHD simulation. For this purpose, Voyager 2 plasma and magnetic data during the period Sept. 10, 2001-Dec. 3, 2006 were used as the inner-boundary condition of the simulation. New findings of the global and dynamical structure of the outer heliosphere are discussed: (1) the identification of a LISM pressure that ensures the V1's TS-crossing at 94 AU; (2) the response of the TS to interplanetary disturbances; (3) the time-varying distance of the TS from the sun along the sun-V1 line during the past 5 years; (4) the propagation of solar disturbances in the heliosheath and beyond; (5) the synchronous motion of the heliopause and the TS. In addition, the relation between the TS-particle events before the V1's TS-crossing and the calculated TS-position and shock-structure are also discussed: (6) an evident relation between the solar-wind high-ram pressure pulses and the TS-particles observations; (7) the relation between the missing TS-particles at the TS-crossing and the end of a series of high-ram pressure pulses associated with the Halloween events. From these studies, we propose a new particle-acceleration model to explain the V1 cosmic-ray observations consistently. We also provide a new analytical description of the solar-wind deceleration between the positions of V1 and V2 by estimating the time-correlation between the simulated-magnetic-field at the V1 position with the observed V1 magnetic field. Our analysis indicates that the time delay due to the deceleration is about 15 days in the course of about 80 days journey of the solar wind for about 20 AU between the positions of V2 and V1. The motion of the TS along the sun-V2 line is also discussed.

Keywords: outer heliosphere, termination shock, dynamic heliosheath

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ASIV031 **Oral Presentation** **3678**

Application of the path model to the modeling of specific SEP events

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Gang Li, Gary P. Zank, Qiang Hu

We will present results on modeling of energetic particle acceleration at a traveling quasi-parallel CME-driven shock. We apply the numerical model, Particle Acceleration and Transport in the Heliosphere (PATH) developed at University of California at Riverside, to model realistic SEP events. We initiate the code by modeling a quiet-time solar wind background and then follow the propagation and evolution of an MHD shock from a distance of ~0.1 AU to the Earths orbit. The model utilizes solar wind parameters measured in situ by ACE. A semi-analytical approach is applied to simulate particle acceleration at the shock by injecting solar wind suprathermal ions locally. The diffusive shock acceleration mechanism due to the repeated scattering of ions back and forth across the shock by Alfvenic turbulence in the vicinity of the shock is adopted in the model. Monte-Carlo approach is used to follow transport of the energetic particles after they escape from the shock front. The output of the PATH model includes time-dependent energetic particle fluxes, spectra and compositional ratios for protons and heavy ions. We will match out modeling results directly with ACE measurements for the specific SEP event of September 29, 2001.

Keywords: sep, modeling, heliosphere

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ASIV031 **Oral Presentation** **3679**

Global modeling of cosmic ray interaction with the heliosphere

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The modelling of the interaction of cosmic rays with the heliosphere has made significant progress during recent years. Modern simulations are based on multifluid as well as hybrid models in three dimensions, self-consistently contain magnetic fields and energetic particles, and include solar cycle variations as well as a changing interstellar environment. The review will put the recent modelling advances into the framework of interstellar-terrestrial relations. There is increasing evidence that there exist such interstellar-terrestrial relations and that the heliosphere's effectivity to serve as a protecting shield for the Earth, specifically against cosmic rays, is varying in time. A debate is going on whether, amongst other drivers, the Sun or the cosmic rays are influencing the terrestrial climate, particularly on periods of hundred years and shorter. It will be discussed how the modelling of the transport of cosmic rays in the heliosphere can contribute constructively to this debate.

Keywords: cosmic rays, heliosphere, interstell terr relations

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ASIV031 **Oral Presentation** **3680**

The inertial range of solar wind MHD turbulence

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IAGA

Luca Sorriso-Valvo, Roberto Bruno, Alain Noullez, Vincenzo Carbone

In hydrodynamic turbulence, an important exact law linearly relates the kinetic energyflux through the scales with the scale itself. This law should be used to exactly definethe inertial range of a turbulent flow, and is often referred to in literature as the "4/5"law. The analogous of such law is obtained here for the magnetized fluids in the magnetohydrodynamicregime. Solar wind data measured by the spacecraft Ulysses havebeen used to show that the above exact law is satisfied, within some periods, in thesolar wind turbulence with great accuracy and over an extended inertial range. Thisis the first clear evidence of a magnetohydrodynamic turbulent cascade occurring insolar wind plasma, and carry with it many important informations about the plasmastate, involving for example compressive and anisotropic effects, Alfvnic decorrelations,and so on. Moreover, the MHD pseudo-energy transfer rate in the solar windturbulence can be measured directly from the data, and the inertial range can be unambiguouslyidentified.

Keywords: solar wind, turbulence, scaling

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ASIV031 **Oral Presentation** **3681**

Escaping ions in quasi-perpendicular shocks

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M. Balikhin, M. Liverts

Field-aligned ion beams and gyrating ions are observed in the foreshock far from the shock front. These ions are generated at the quasi-perpendicular shock front together with the regular reflected ions. The dependence of the distribution of escaping ions on the angle between the shock normal and the upstream magnetic field, magnetic compression ratio, cross-shock potential, and beta of incident ions, is studied.

Keywords: shocks, waves, acceleration

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ASIV031 **Oral Presentation** **3682**

Observations of Particle Acceleration at Interplanetary Shocks

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From supernova remnant shocks to the solar wind termination shock, interplanetary (IP) shocks and planetary bow shocks, collisionless shocks are responsible for much of the energetic particle acceleration throughout the Universe. Particles can gain energy while interacting with shocks in many different ways. Each acceleration mechanism produces distinct features in energetic particle anisotropies, spectral indices, and time intensity profiles. Thus, a study of in-situ IP shocks and particle distributions in their vicinity provides the only meaningful way to test our theoretical understanding of shock acceleration. During the current solar cycle, advanced instrumentation from Wind and ACE spacecraft detected over 300 interplanetary shocks. More than half of these shocks produced signatures (so called ESP events) in the low energy ion intensities. Of these ESP events, most of the measured particle spectral indices do not agree with steady-state diffusive shock-acceleration theory. Instead, ion spectra measured at the shock are often similar but softer than spectra of ambient ions measured well upstream of the shock. In addition, some of the ESP events have odd compositional signature similar to those found in 3He-rich solar energetic particle event. In this paper, we will review the observations of particle acceleration at IP shocks and will discuss the implication of such results in terms of seed particle population being accelerated by IP shocks when they reach 1 AU.

Keywords: shock, acceleration, heliosphere

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ASIV031 **Oral Presentation** **3683**

MHD-neutral Modeling of the Heliosphere

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Gary P. Zank, Tatsuki Ogino

We review the achievements in the theoretical modeling of the heliospheric interface. Special attention is paid to the following phenomena which allow us to relate modeling results to spacecraft observations. (i) The interstellar magnetic field (ISMF) strength and direction can potentially affect the distribution of the 2-3 kHz radio emission sources which are believed to originate ahead of the heliopause that separates the solar wind (SW) from the local interstellar medium (LISM). (ii) Nonalignment of the interplanetary magnetic field (IMF) with the termination shock (TS) surface can result in transverse streaming anisotropies of energetic charged particles observed by Voyager 1 (V1) at 92 AU in cases when the ISMF component parallel to the ecliptic plane makes the TS east-to-west asymmetric, thus allowing the spacecraft ahead of the TS be directly connected to the heliosheath by an IMF line. (iii) Voyager 2 (V2), which is now at about 80 AU from the Sun and travelling in the southern hemisphere at approximately the same angle to the ecliptic plane as V1 did in the northern hemisphere, has already started measuring similar streaming anisotropies. This can be caused by a north-south asymmetry of the TS. (iv) ISMF-induced asymmetries are readily seen in the energetic neutral atom all-sky maps. (v) Recent measurements from the Solar Wind Anisotropies experiment on board of the Solar and Heliospheric Observatory (SOHO) satellite discovered a divergence of the neutral hydrogen flow by 4 degrees with respect to the neutral helium direction at distances less than 10 AU to the Sun. This allows us to constraint the range of possible ISMF orientations.(vi) An ISMF with the strength of about 3-5 microgauss in strength can result in a highly asymmetric distribution of neutralhydrogen throughout the heliosphere. Such distributions are likely to affect Ly-alpha absorption profiles in directionstoward different nearby stars. As a result, such observations can be used to rule out certain orientations and strengths of the ISMF. (vii) The effects of the slow-fast solar wind region separation in the context of the Sun's 11-year activity cycle, coronal mass ejections, and global merged interactions regions strongly affect the location and shape of the TS in a time-dependent manner. (viii) Instabilities of the heliopause can result in the generation of soft X-ray emission to be observed by spacecraft. The analysis of the presented modeling results is summarized by formulating grand challenges in the development of physically-consistent numerical approaches to analyze the SW-LISM interaction.

Keywords: heliosphere, mhd

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ASIV031 **Oral Presentation** **3684**

Particle Acceleration at Interplanetary Shocks

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Understanding the problem of particle acceleration at interplanetary shocks is assuming increasing importance, especially in the context of understanding the space environment. The basic physics was thought to have been established in the late 1970s and 1980s, but detailed interplanetary observations are not easily interpreted in terms of the simple original models of particle acceleration at shock waves. Three fundamental aspects make the interplanetary problem much more complicated than the typical astrophysical problem: the time dependence of the acceleration and the solar wind background; the geometry of the shock; and the long mean free path for particle transport away from the shock wave. These aspects have been explored in the context of proton acceleration at interplanetary shocks. Understanding this is of importance to understanding the acceleration of heavy ions at interplanetary shocks since wave excitation, and hence particle scattering, at oblique shocks is controlled by the protons and not the heavy ions. The heavy ions behave as test particles and their acceleration characteristics are controlled by the properties of proton excited turbulence. As a result, the resonance condition for heavy ions introduces distinctly different signatures in abundance, spectra, and intensity profiles, depending in ion mass and charge. Self-consistent models of heavy ion acceleration and the resulting fractionation are discussed. This will include discussion of the injection problem and the acceleration characteristics of quasi-parallel and quasi-perpendicular shocks.

Keywords: energetic particles

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ASIV031 **Oral Presentation** **3685**

Particle acceleration at shocks: beyond the diffusion approximation

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Gary Zank, Jakobus Le Roux

It has long been thought that most of the energetic charged particles that pervade the heliosphere were accelerated by collisionless shocks. The theory of diffusive shock acceleration provides a natural explanation of the observed power-law energy spectra associated with these particles. However, there have been numerous in-situ spacecraft measurements that do not agree with the predictions of simple diffusive shock acceleration theory. One striking example that has generated considerable controversy recently is the Voyager 1 crossing of the termination shock. Contrary to the predicted single uniform power-law like distributions observations featured highly-anisotropic upstream particle beams and multiple power-law populations separated by spectral breaks. The departures from the standard diffusive acceleration picture occur because (a) shocks are not ideal, i.e., they have a complex spatial structure and evolve in time owing to interactions with upstream plasma structures, and (b) particle distributions are highly anisotropic, especially in the vicinity of oblique and quasi-perpendicular shocks. We investigate both theoretical aspects of shock acceleration using a series of simple models. We demonstrate that particle populations observed near an evolving shock are a superposition of separate distributions accelerated at different times in the past when the shock compression ratio and interplanetary transport parameters were different from their present-day values. For example, particles accelerated at a dynamictermination shock possess a multiple-component spectrum that is qualitatively similar to the Voyager 1 spectra, with lowest energy particles accelerated most recently at a stronger shock, and the softer higher-energy component accelerated earlier when the shock was weak. Using the newly-developed model of anisotropic particle transport we investigate the effects of adiabatic focusing and magnetic mirroring on the diffusive acceleration process at a highly oblique shock wave, such as the solar wind termination shock. It is shown that magnetic reflection causes particle intensities to become discontinuous and sharply peaked at the shock front. We also demonstrate that particle spectra do not have the simple power law slope but exhibit spectral gaps near the low-energy acceleration threshold.

Keywords: heliosphere, particle, acceleration

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ASIV031 **Oral Presentation** **3686**

Simulation study of EM radiation from LANGMUIR/Z waves in warm magnetized plasmas

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Peter A. Robinson

Linear mode conversion (LMC) of Langmuir waves to radiation near the plasma frequency at density gradients is relevant to solar and interplanetary radio bursts, planetary foreshocks, and perhaps pulsar radio emissions. We study LMC in warm magnetized plasmas using numerical electron fluid simulations as functions of the angles between the density gradient, ambient magnetic field (B0), and wavevector. The dependences of the mode conversion efficiency on B0, spatial scales of density gradients, incidence angle θ of the Langmuir wave, relative to the density gradient, and the angle α between density gradient and B0 are presented. The mode conversion window narrows asB0 increases and the conversion efficiency increases as α increases. We show strong evidence that LMC produces extraordinary (x) mode as well as ordinary (o) mode radiation from Langmuir waves. Equal amounts of o- and x-mode radiation are produced in the unmagnetized limit at least when α is small. Possible applications of LMC to the solar radio bursts in the solar wind and corona, and to planetary continuum radiation are also explored and it is suggested that LMC can explain linear and/or elliptical polarizations of type II and III solar radio bursts.

Keywords: radio emission, mode conversion

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ASIV031 **Oral Presentation** **3687**

Data-driven solar wind model and prediction of type II bursts

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Magali Florens, Stuart Knock, Peter Robinson

Type II solar radio bursts are produced by shock waves moving through the corona and solar wind. An existing theory predicts the Type II dynamic spectrum by considering electron acceleration at the shock, growth of Langmuir waves, and their conversion into radiation, thereby connecting the wave and particle microphysics to the macroscopic rippled shock. Two contributions are presented. First, a more realistic 2-dimensional model for the solar wind is constructed for specified time periods from spacecraft data at 1 AU. It converts time to longitude and extrapolates to different heliocentric distances using MHD-like equations and power-law temperature profiles. Second, the type II theory is combined with the data- driven solar wind model to predict the dynamic spectrum for a specific Type II burst. The results show good qualitative agreement with the observations, as well as demonstrating that shock interactions with corotating interaction regions lead to enhanced emission. The new theoretical model for Type II bursts is relevant to NASA's STEREO mission and space weather research.

Keywords: radio bursts, solar wind, stereo

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ASIV031 **Oral Presentation** **3688**

Investigating turbulent structure in the ionosphere using the Halley SuperDARN radar.

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Mervyn P. Freeman, Gareth Chisham, Nicholas W. Watkins

We present a detailed analysis of the spatial structure of the ionospheric F-region plasma velocity in the nightside ionosphere, poleward of the open-closed field line boundary (OCB), i.e., in regions magnetically connected to the turbulent solar wind. We make use of spatially distributed measurements of the ionospheric plasma velocity made with the Halley Super Dual Auroral Radar Network (SuperDARN) radar between 1997 and 2001. We analyze the spatial structure using structure functions which provide a simple method for deriving information about the scaling and intermittancy of the fluctuations that can be used to differentiate between different turbulence models. We find that the limited range of velocity that can be measured by the Halley SuperDARN radar restricts our ability to calculate structure functions. We correct for this by using conditioning (removing velocity fluctuations larger than 3 standard deviations from our calculations). The resultant structure functions suggest that a P model of Kraichnan-Iroshnikov turbulence best describes the velocity structure seen in the ionosphere.

Keywords: ionosphere, turbulence, superdarn

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ASIV031 **Oral Presentation** **3689**

Superdiffusive transport of energetic particles in solar wind turbulence

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The transport of energetic particles in a mean magnetic field and in the presence of anisotropic magnetic turbulence is studied numerically, for parameter values relevant to space plasmas. A numerical realization of magnetic turbulence is set up, in which we can vary the type of anisotropy by changing the correlation lengths parallel and perpendicular to the background field. We also change the ratio ρ/λ of the particle Larmor radius ρ over the turbulence correlation length λ. We find that for lx much larger than lz and for ρ/λ < 10−2 transport can be non Gaussian, with superdiffusion along the average magnetic field and subdiffusion perpendicular to it. Also, the spatial distribution of particles is clearly non Gaussian. Such regimes are characterized by a Levy statistics, with diverging second order moment and power law propagator. Changing the particle Larmor radius, normal diffusion is found for 10−2 < ρ/λ < 1 because of increased pitch angle diffusion. We compare our results with the Ulysses observations of energetic particles at corotating interaction regions, which show indications of superdiffusion.

Keywords: superdiffusion, turbulence, shocks

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ASIV031 **Oral Presentation** **3690**

Electron dynamics and cross-shock potential at the quasi-perpendicular bow shock

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Steven J. Schwartz

The evolution of the electron distribution function through quasi-perpendicular collisionless shocks is believed to be dominated by the electron dynamics in the large-scale coherent and quasi-stationary magnetic and electric fields. Using data from the Cluster mission, we compare features of the observed distributions with those predicted by electron dynamics resulting from conservation of the first adiabatic invariant and energy in the de Hoffmann-Teller frame, for all pitch-angles and all types of trajectories (passing, reflected or trapped).For a particular crossing, we could take advantage of the configuration of the Cluster quartet to compare mapped upstream velocity distributions with those simultaneously measured at a relatively well magnetically-connected downstream location. Consequences of energy and adiabatic invariant conservation are found to be compatible with the observed electron distributions, confirming the validity of electron "heating"theories based on DC-fields as zeroth order approximations, but some systematic deviations are found between the dynamics of low- and high-adiabatic invariant electrons. Our approach also provides a way to estimate the cross-shock electric potential profile making full use of the electron measurements, and the results are compared to other estimates relying on the steady-state dissipationless electron fluid equations. Finally, in contrast to methods using electron velocity-moments, the technique can be used to produce high-time resolution electric potentials.

Keywords: shocks, heating

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ASIV031 **Oral Presentation** **3691**

Toward multi-component simulations of the partially ionized ISM interacting with the 3D rotation-averaged solar wind

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A self-consistent axisymmetric multi-fluid simulation code (plasma, three neutral components, no magnetic fields) of the interaction of the solar wind with the partially ionized local interstellar medium is being expanded into three dimensions to accommodate the 3D nature of the solar wind. Recent estimates for the solar wind variation with heliolatitude and with phase in the 11 year solar activity cycle based on Ulysses data and the Wang-Sheeley solar wind expansion model are used as input conditions. This input is solar rotation averaged and does not account for solar wind variations at higher frequencies (e.g. CMEs). The resulting transient plasma features and asymmetries obtained with a preliminary working model are discussed, as are their effect on the neutral hydrogen distributions throughout the heliosphere.

Keywords: simulations, 3d, neutral

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ASIV031 **Oral Presentation** **3692**

Heliospheric distribution of the solar EUV flux over the latest solar cycle

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ASIV031 **Oral Presentation** **3693**

Transport of energetic particles by large amplitude MHD turbulence

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Y. Nariyuki

Transport of energetic particles by magnetohydrodynamic (MHD) waves is one of the most important and fundamental issues in space plasma physics. Although quasi-linear theory has been successfully utilized for various applications, the theory fails when the turbulence amplitude is large, e.g., when the theory is applied to the foreshock turbulence. We discuss some fundamental properties of the energetic particle transport by large amplitude MHD turbulence (which often includes MHD coherent structures), by performing test particle simulations. Deviations from the quasi-linear theory will be discussed in detail.

Keywords: magnetohydrodynamic, foreshock turbulence

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ASIV031 **Poster presentation** **3694**

Possibility to see the structure of the heliopause by analysis of fluxes of neutralized solar wind heavy ions

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We developed a global heliospheric model of distribution of charge-states of coronal C, N, O, Mg, Si, S ions carried by the solar wind and neutralized by consecutive electron captures from neutral interstellar atoms. The heavy ions, treated as test particles, are carried by hydrodynamic plasma flow against a Monte-Carlo described inflow of interstellar neutrals. and undergo all relevant atomic processes determining the evolution of their charge-states (radiative and dielectronic recombination, charge exchange, photo-, and electron impact ionization). We show that the decharged solar wind ions constitute an important new source of neutral atoms in the inner heliosheath, with energies up to ~ 1 keV/n. Our calculations point to important differences in the spatial distributions of ions of low and high charge states. This results in interesting consequences for the diagnostic of the heliosphere. A common feature of all ion distributions of considered species is that close to the heliopause a layer of relatively high density of singly ionized ions develops in the heliosheath. This layer is a source of Energetic Neutral Atoms of C, N, O, whose expected fluxes at 1 AU amount to about 0.2 -1.6 cm^-2 s^-1 sr^-1. The atoms that cross 1 AU will eventually be ionized and could contribute to the inner source of pickup ions, being able to explain at least an appreciable portion of their flux. We expect the mentioned ENA fluxes could be recorded by the forthcoming heliospheric experiment IBEX and thus could provide independent means to study the subheliopause layers. An additional interesting possibility is to measure ENAs directly from the heliospheric tail that could provide an independent estimate of the direction of the apex-antiapex axis.

Keywords: heliosheath, neutrals, charge states

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ASIV031 **Poster presentation** **3695**

Particle acceleration from fluctuating electric fields superposed on X-type magnetic fields

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Particle distributions are obtained by numerically integrating individual charged particle orbits when a time varying electric field is superimposed on a static X-type neutral point. This configuration represents the effects of the passage of a generic MHD disturbance through such a system. Different frequencies of the electric field are used, representing different possible types of wave. The resulting particle distributions have properties that depend on the amplitude and frequency of the electric field. In many cases a bimodal form is found. Depending on the timescale for variation of the electric field, electrons and ions may be accelerated to different degrees and often have energy distributions of different forms. Protons are accelerated to gamma-ray producing energies and electrons to and above hard X-ray producing energies in timescales of 1 second. The acceleration mechanism is possibly important for solar flares and solar noise storms but is also applicable to all collisionless plasmas

Keywords: particleacceleration, magneticreconnection, solarflares

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ASIV031 **Poster presentation** **3696**

Parametric instabilities of parallel propagating incoherent Alfven waves

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Large amplitude Alfven waves are ubiquitous in the solar wind, and are believed to play important roles in acceleration and heating of the solar wind plasma. The solar wind Alfven waves are typically robust for linear ion-cyclotron damping (due to small wave frequencies) and also for linear Landau damping (due to small propagation angle relative to the back ground magnetic field). On the other hand, through parametric instabilities, they can transfer their energy into longitudinal waves, which subsequently heat the background plasma through the ion Landau damping. The numerical experiments for parametric instabilities of incoherent Alfven waves, which have a power-law type spectrum as actually observed in the solar wind, are carried out. The reason why the decay instability of incoherent waves can be explained in terms of that of the coherent wave is understood through the analysis on nonlinearly driven finite amplitude density fluctuations. Numerical results suggest the importance of modulational instabilities of left-hand polarized waves. Also, the finite ion temperature effects, which may be significant in the solar wind near the Earth, will be examined in detail.

Keywords: alfven waves, solarwind

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ASIV031 **Poster presentation** **3697**

Consequences of finite ion temperature effects on parametric instabilities of circularly polarized Alfven waves

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Parametric instabilities of finite amplitude, circularly polarized parallel propagating Alfven waves in homogeneous plasma is discussed analytically, taking into account the ion Landau damping and ion Finite Larmor Radius (FLR) effects. A hybrid kinetic-fluid model is systematically derived from one-dimensional Vlasov equation for ion motion in longitudinal direction and the FLR-Hall Magnetohydrodynamic (MHD) equations for transverse directions. The longitudinal kinetic effects are retained in the model, whereas transverse kinetic effects such as ion cyclotron damping is neglected. Validity of the model is justified as far as the collisionless damping is concerned, since the ion cyclotron damping for typical quasi-parallel Alfven waves in the solar wind is considered to be extremely small. As already shown in a number of past studies, inclusion of the kinetic effects let some new instabilities emerge, while that reduces the growth rates of fluid instabilities in general. Furthermore, as a consequence of the FLR effects, the growth rates of the fluid instabilities of the LH- (RH-) mode are reduced more strongly (weakly) in the FLR-Hall-MHD model than in the Hall-MHD model. Numerical results of the present model and those of the models using collision-like (local) damping terms do not agree well, suggesting the importance of using the exact Landau-type interactions. We also carried out the hybrid simulation. The models and results demonstrated here can be applied to the parametric instabilities of Alfven waves in the solar wind near the earth, in which finite ion temperature effects are eminent.

Keywords: alfven waves, solar wind, ion kinetics

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ASIV031 **Poster presentation** **3698**

The evolution of the mirror mode using 1-D fluid simulation

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The mirror modes are compressible slow mode, typically excited in high-beta plasmas where there is a significant pressure anisotropy. The 1-D fluid simulation of such a mode is performed for anisotropic pressure plasmas in the magnetosphere. The set of conservation equations for mass, momentum and energy for a two fluid plasma coupled to Maxwell's equations for the electromagnetic field is written in a composite conservative form. Allowing for wave propagation in one dimension using periodic boundary conditions, we illustrate the evolution of mirror modes for magnetosheath parameters.

Keywords: mirror modes, fluid simulation

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ASIV031 **Poster presentation** **3699**

Energetic ions upstream of the Earths bow shock observed by GEOTAIL

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Energetic ions are at times observed in the upstream region of the Earths bow shock, and they are thought to be produced at the bow shock. While the energy of the solar wind ions is a few keV at most, the energy of the backstreaming ions ranges from several 10 keV to several MeV. Candidates for the production mechanism of the backstreaming ions at the bow shock include specular reflection, leakage from downstream of the shock, shock drift acceleration, and diffusive shock acceleration. Since the production mechanisms are controlled both by the angle between the upstream magnetic field and shock normal direction and by upstream solar wind parameters, the local shock configuration is crucial for inferring the determining production mechanism of the energetic ions. In the present study we investigate backstreaming energetic ions observed by Geotail during a CME event. In addition to field-aligned beams that often exist in the upstream region of the bow shock, we find loss cone distribution of backstreaming ions whose energy is between about 20 keV and several hundred keV. These two distinct populations as well as their energies depend on the local shock angle. We will discuss in detail the shock structure and the mechanism for the production of energetic ions at the bow shock on the basis of the observed properties.

Keywords: energeticions, bowshock, losscone

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ASIV031 **Poster presentation** **3700**

Simulation of shock reformation physics and electron energisation at collisionless shocks

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Peter A. Robinson

Numerical simulations have revealed a strongly nonstationary behavior for shock waves with parameters relevant in heliospheric and astrophysical contexts. This behavior is characterized by cyclical reformation on the spatio-temporal scales of the upstream ion gyroperiod and convected ion gyroradius. In this paper we study, first, the dynamics of low plasma beta ($beta=0.05$), high Alfv'{e}n Mach number ($M_{A}=4sim 5$), quasi-perpendicular ($theta_{bn}=87 ^{circ}$) collisionless shocks and, second, the production of burst of energetic electrons by the time-dependent reforming shocks self-consistently generated by an one-dimensional hybrid code. We show that the additional electron dissipation in the extended hybrid simulations leads to a strong ion thermalization and phase space mixing between upstream incoming and reflected ions via plasma wave interactions in the foot, and formation of ion phase space holes. Two plasma wave populations are observed in the foot, and ramp region. Whistler waves, mostly in the foot and ramp regions, have typical wavelengths and frequencies of $0.3v_{A}Omega_{ci}^{-1}$ and $16Omega_{ci}^{-1}$, respectively, cause strong mixing between upstream incoming and reflected ions that corresponds to strong ion heating. Lower hybrid waves extend throughout the foot and downstream region, and are not effective in heating ions. By using test particle calculations in the electromagnetic fields of reforming shocks (produced by the standard hybrid simulation), we show that bursts of energetic electrons are released into upstream region. The bursts cyclically occur at the shock reformation period and are qualitatively very different from the continuous beam expected for a time-stationary shock.

Keywords: shockreformation, electronenergisation, hybridsimulations

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ASIV031 **Poster presentation** **3701**

Kappa velocity distribution results after modeling thermal fluctuations in the turbulent plasma sheet

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Daniel N Baker

Kappa velocity distributions are common to laboratory and space plasmas, and exhibit long power law (suprathermal) tails in comparison to Maxwell Boltzmann distributions. Various processes, including spontaneous scattering by Langmuir and ion sound waves, charge fluctuations, polydispersity in diffusing particle or random media sizes, induced scattering by photons, and other processes may generate kappa velocity distributions. Since electron and ion velocity measurements in the plasma sheet suggest a highly turbulent state, we consider whether thermal fluctuations in MHD turbulence are sufficient to generate kappa velocity distributions. We model the thermal fluctuations by Langevins equation with a white noise driver. The noise variance is set proportional to the expectation of the square of the local Kolmogorov speed in the turbulent plasma. The modeled variance fluctuates at times sampled from an exponential distribution representing independent increments in mean waiting interval between times of particle interaction with the turbulent plasma. The histogram for the resulting velocity distribution is plotted at preselected times, demonstrating the evolution from a chosen initial distribution to the kappa distribution.

Keywords: plasmasheet, turbulence, fluctuations

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ASIV032 **3702 - 3729**

Symposium
IHY and universal processes (Divisions IV, II, and III)

Convener : Dr. Joseph Davila

On October 4, 1957, only 53 years after Kitty Hawk, the launch of Sputnik marked the beginning of the space age. Discovery of the radiation belts, the solar wind, and the structure of Earths magnetosphere prepared the way for human exploration to follow. Today a similar story is unfolding, as the spacecraft Voyager is leaving the heliosphere, and for the first time, humans will begin to explore the local interstellar medium. It is inevitable that, during the next 50 years, exploration of Mars and the Outer Planets will be the focus of the space program, and a better understanding of the global heliophysical processes will be required. Like the IGY before it, The International Heliophysical Year (IHY) will focus on the cross-disciplinary physics governing all of heliophysics through the study of Universal Processes in the solar system. Basic science themes are (1) Evolution and Generation of Magnetic Structures and Transients, (2) Energy Transfer and Coupling Processes, (3) Flows and Circulations, (4) Boundaries and Interfaces: Sheaths, Shocks, and Layered Interfaces, and (5) Synoptic Studies of the 3D Heliosphere. Contributions on plasma processes, particle acceleration/propagation, solar phenomena, magnetospheric/heliospheric processes, the coupling of planetary atmospheres to the space environment, etc. are sought.

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ASIV032 **Oral Presentation** **3702**

Universal classification principles of solar and heliospheric processes: dimensionless scaling

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Different classification principles of solar and heliospheric phenomena will be considered. Morphological and historical principles dominate in the literature. They are not often based on quantitative grounds. Common terminology is rather arbitrary when using terms 'large – small', 'fast – slow', 'cool – hot' etc. Less ambiguous classifications are based on comparative estimates of different scales and parameters. Dimensionless scaling is very useful for this purpose. The complete set of dimensionless plasma and electromagnetic parameters met in dissipative MHD with radiation and kinetic plasma theories will be presented. It contains well known numbers like Mach, Mach-Alfvn, Knudsen, Reynolds, magnetic Reynolds and many others. In addition, relatively new independent characteristics like Faraday number, "velocity-emission" number, Trieste numbers will be presented. They are playing the important physical role, which is still not appreciated in the literature on solar and heliospheric phenomena. Many of them are still not evaluated quantitatively and even qualitatively for solar flares, coronal mass ejections and other solar activity phenomena. It is because of not sufficient observational information. Examples of universal classifications based on dimensionless scaling will be discussed and compared with traditional morphological descriptions. CMEs and flares, externally driven and local phenomena, turbulent and laminar motions can be better described and represented in this way. We suggest that dimensionless parameters will be used during IHY as a clear physical language for the correct statement of problems. This approach is universal and unambiguous. The work was supported by the grants RFBR 04-02-16736, 06-05-64500 and INTAS 03-51-6202. It is fulfilled also as a part of the Innovative Program of the Moscow State University and Programs of the Russian Academy of Sciences ''Origin and evolution of stars and galaxies'', P16 and OFN16. References I .S. Veselovsky. Dimensionless scaling approaches to the solar and heliospheric processes. JASR 2007 (accepted).

Keywords: universal classification

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ASIV032 **Oral Presentation** **3703**

Sheaths: A comparison of ICMEs, Planets, and the Heliosphere

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Sheaths are the regions behind shocks, between the shock and the downstream obstacle. For ICMEs this is the region between the interplanetary shock and driver gas. Magnetosheaths are the regions between planetary bow shocks and magnetopauses. The heliosheath is the region between the termination shock and the heliopause currently being explored by Voyager 1. All these regions contain plasma slowed, compressed, and heated by the shock. But the length scales range from tens of RE for Earth to hundred of AU for the heliosheath. Nonetheless, similar phenomena are observed. Magnetic holes probably associated with mirror mode waves are observed in all three of these sheaths. Plasma depletion layers form in planetary and ICME sheaths. We show examples of and discuss similarities and differences of these three types of sheaths observed in the heliosphere.

Keywords: sheaths, shocks

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ASIV032 **Oral Presentation** **3704**

Solar cycle dependence of solar wind structure

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Munetoshi Tokumaru, Ken-Ichi Fujiki

We have studied the solar cycle dependence of solar wind properties using IPS data obtained at STELab over a solar cycle. The mean velocity at the polar region was 789+/-68 km/s throughout the analysis period except for a few years around the solar maximum, and there was no systematic change in velocities when the latitudinal lower boundary of the polar coronal hole changed from 60 to 80 degrees. This means that the speed of the polar solar wind was independent of the solar cycle except for the maximum phase. When the polar coronal hole shrank to a size smaller than a critical scale size of about 5*10^10 km^2 in the solar maximum phase, it became the source of the slow solar wind. The fast and slow solar wind are separated by a steep velocity gradient, even if the scale of the high-speed region changes. The high-latitude fast wind had a N-S asymmetry in velocity, which was a stable characteristic that lasted throughout the whole solar cycle we analyzed. From these studies it is illustrated how the latitudinal structure changes with the solar activity. In the descending and ascending phases of solar activity, the velocities of low-speed wind and high-speed wind do not change, and the boundary between the low-speed and high-speed regions is always steep, while the latitudinal width of the low-speed region and the latitudinal velocity gradient in the high-speed region changed.

Keywords: solar wind, solar activity, 3d structure

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ASIV032 **Oral Presentation** **3705**

Turbulence generation and propagation from the Sun to the Heliosphere

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Bruno Bavassano, Raffaella D'Amicis, Vincenzo Carbone, Luca Sorriso-Valvo

Fluctuations of the interplanetary medium clearly exhibit a turbulent behavior throughout several frequency decades. Moreover, it has been observed a frequency drift of the breakpoint marking the border between the injection scales and the inertial range towards lower and lower frequencies during the wind expansion. This suggested that larger and larger scales are being involved in the turbulent process via non-linear interactions during turbulence evolution. In order to have this mechanism active it is necessary that the non-linear term in the Navier-Stokes equation be different from zero and much larger than the linear dissipative term. It follows that both "inward" and "outward" Alfvn modes must be present at the same time in our turbulent sample and this condition requires the existence of some generating mechanism able to locally produce "inward" modes beyond the Alfvnic critical radius. This presentation aims to provide an overview of the main features characterizing the radial evolution of MHD turbulence as observed in the heliosphere and the main production mechanisms believed to be the driving processes of the solar wind turbulent behavior.

Keywords: solar wind, mhd turbulence, nonlinear processes

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ASIV032 **Oral Presentation** **3706**

Characteristics of the Space Environmental Viewing and Analysis Network (SEVAN)

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One of the major advantages of multi-particle detectors is probing of the different populations of the primary cosmic rays, initiated particle cascades in terrestrial atmosphere. With basic detector of SEVAN network we are measuring fluxes of neutrons and gammas, of low energy charged component and high energy muons. This diversity of information obtained from SEVAN network located mostly at low and middle latitudes will give possibility to estimate the energy spectra of the highest energy Solar Cosmic Rays (SCR). SEVAN network will be sensitive to very weak fluxes of SCR above 10 GeV, very poorly explored till now. To understand sensitivity of new type of particle detectors to highest energy solar ions we investigate the response of SEVAN basic units to galactic and solar particles. New physical inference methods are proposed and tested for: estimation of the index of power spectra of solar cosmic rays incident on the terrestrial atmosphere, distinguishing of the ground level enhancements initiated by solar neutrons.

Keywords: galactic cosmic rays, solar cosmic rays, ground level enhancements

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ASIV032 **Oral Presentation** **3707**

Remote Sensing of the Lower Ionosphere with AWESOME VLF Receivers

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Morris Cohen, Phil Scherrer, Deborah Scherrer

Very Low Frequency (VLF) radio receivers have long been used for remote sensing of the ionosphere and the radiation belts. Broadband VLF measurements capture naturally produced electromagnetic waves (e.g., chorus, lightning-generated whistlers, hiss) in wideband fashion, while narrowband measurements of VLF transmitter signals allow the measurements of localized and transient disturbances of the D-region. Among the phenomena that are uniquely measured via VLF receivers are radio atmospherics, whistlers, lightning-induced electron precipitation, solar flares, sudden ionospheric disturbances, gravity waves, sprites, and terrestrial and cosmic gamma-ray flashes and flares. In recent years, Stanford University has developed an extremely low cost VLF receiver system that is known as AWESOME (Atmospheric Weather Educational System for Observation and Modeling of Electromagnetics) which GPS-based timing accuracy (<200 ns), high-sensitivity (less than femtoTeslas or 0.1 microvolts per root Hz in the range ~300 Hz to 50 kHz) and data handling flexibility. Such sensitivities well exceed that required to detect any event above the ambient atmospheric noise floor, determined by the totality of lightning activity on this planet and the timing accuracy allows the use of these instruments in the form of arrays, to perform interferometric and holographic imaging of the lower ionosphere. In the context of the IHY/UNBSS program for 2007, the AWESOME receivers are now being deployed in developing countries. Drawing on the Stanford experiences from setting up arrays of VLF receivers, including an interferometer in Alaska, the Holographic Array for Ionospheric and Lightning research (HAIL) consisting of instruments at 13 different high schools in mid-western United States, a broader set of ELF/VLF receivers in Alaska, and various receivers abroad, including in France, Japan, Greece, Turkey, and India, a global network of ELF/VLF receivers offer possibilities for a wide range of scientific topics, as well as serving as a means for educational outreach. The locations at which AWESOME receivers have already been placed include several North African countries, including Tunisia, Algeria, and Morocco. In March 2007 AWESOME receivers will be deployed in Libya and India. In spite of their low cost, the AWESOME receivers offer the same ultimate levels of resolution in time, sensitivity and dynamic range, as well as ease of handling of data that is used by researchers conducting cutting edge ionospheric and Space Weather. In this context, the placement of these systems at developing host countries provides an open-ended potential for exploration, limited only by the imagination and drive of the users.

Keywords: vlf, ionosphere, ihy

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ASIV032 **Oral Presentation** **3708**

Scientific but People Oriented Education (SPOE) & International Heliophysical Year (IHY) Outreach

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IHY & Universal Processes SpaceSouth International

Prof. Ekundayo E. Balogun, Dr. Babatunde A. Rabiu

Space scientists are on an extreme of a scientific orientation divide, while the general public and most policy makers are on the other extreme. For a productive public outreach program, we have to reach a middle ground between the scientists (space scientists) and the general and/or specific public. First, the scientists have to proactively study and communicate what they do to the public, in a form that can be understood and that can motivate the general public and more importantly, our policy makers. In many societies in the world, there are obvious conceptions which cultures hold about heliosphere. Some of these myths are connected to indigenous belief system. Harnessing the benefits of the heliophysical sphere will require the integration of those who are recipients of the technologies and creating a more inclusive framework which empowers the people to be aware of the new benefits inherent in space exploration. This implies an interface between the scientists and social scientists especially the cultural or socio-cultural anthropologists, who will therefore bridge the gap in reaching communities and the general public by engaging the form of communication (language) which is meaningful to specific cultures and the benefiting communities. However, there may be a need to research this concept before any adoption. This is even more crucial especially in the third world states like African states. Access to information and other technology is still expensive and only affordable by the elites. Also the vast majority of the populace resides in the rural areas where some of these facilities are inaccessible and unavailable.

Keywords: spoe, cultural anthropology, 3rd world countries

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ASIV032 **Oral Presentation** **3709**

The distributed Coherent Ionospheric Doppler Receiver (CIDR) network contribution to IHY07

Dr. Trevor Garner

Thomas L. Gaussiran, Ii, Johnathan A. York, Charles M. Slack

The Applied Research Laboratories, the University of Texas at Austin (ARL:UT) has deployed an extensive network of Coherent Ionospheric Doppler Receivers (CIDR) in the Americas. CIDRs measure the time rate of change of the line-of-sight Total Electron Content (TEC) from low-Earth-orbiting (LEO) spacecraft with UHF/VHF radio beacons. These measurements can be integrated to determine the relative TEC along the satellites orbit, and are useful measurements for determining behavior of large-scale (greater than 1) plasma structures within the ionosphere. In addition, the quick satellite transit time across the CIDRs field of view (typically 20 min) and high-rate (user specified between 1-1000 Hz) make the CIDR dTEC/dt measurements sensitive to reasonably small-scale plasma structures (0.15/s ray separation). This presentation outline recent results for CIDR observations of plasma structures in the high, mid-, and low latitude ionosphere, and discusses the further development of the CIDR network.

Keywords: ionosphere, instumentation

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ASIV032 **Oral Presentation** **3710**

On the role played by interplanetary MHD turbulence in the geomagnetic auroral response

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Roberto Bruno, Bruno Bavassano

The solar wind magnetosphere relationship has been widely studied by means of the so-called coupling parameters, very useful in the presence of intense perturbations in the solar wind. However, remarkable variations in the geomagnetic field occur even in absence of such perturbations. In those conditions, MHD turbulence and structures convected by the solar wind might have a role. Recent results have shown that solar wind MHD turbulence can be described not only as a mixture of inward and outward stochastic Alfvnic fluctuations but includes also the presence of convected coherent structures, partially dominated by an excess of magnetic energy. In the present study we focus on the auroral activity in the magnetosphere, as measured by the AE index. We find that at solar minimum Alfvnic turbulence drives the auroral response, while at solar maximum convected structures play a role.

Keywords: alfvenic turbulence, coherent structures, auroral response

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ASIV032 **Oral Presentation** **3711**

Multi-spacecraft study of the January 21st 2005 ICME

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C.J. Owen, S. Dasso, L.M. Green, I. Dandouras, H.A. Elliott, A.N. Fazakerley, Y.V. Bogdanova, N.U. Crooker

We examine the near-Earth Interplanetary Coronal Mass Ejection (ICME) apparently related to the intense Solar Energetic Particle (SEP) event of January 20th 2005. Our purpose is to contribute to the understanding of the macroscopic structure, evolution and dynamics of the solar corona and heliosphere. Using CLUSTER, ACE and WIND data in the solar wind, and GEOTAIL data in the magnetosheath, we perform a multi-spacecraft analysis of the ICME-driven shock, post-shock magnetic discontinuities and ejecta. Traversals by the well-separated near-Earth spacecraft provide a coherent picture of the ICME geometry. Following the shock, the ICME sequence starts with a hot pileup, ie, a sheath, followed by a fast ejecta characterised by a non-compressive density enhancement (NCDE), which is caused essentially by an enrichment in helium. The plasma and magnetic observations of the ejecta are consistent with the outskirts of a structure in strong expansion, consisting of nested magnetic loops still connected to the Sun. Within the leading edge of the ejecta, we establish the presence of a tilted current sheet substructure. An analysis of the observations suggests that the tilted current sheet is draped within the overlying cloud canopy, ahead of a magnetic cloud-like structure. The flux rope interpretation of this structure near L1, confirmed by observations of the corresponding magnetic cloud, provided by ULYSSES at 5.3 AU and away from the Sun-Earth line, indicate that the bulk of the cloud is in the north-west sector as seen from the Earth, with its axis nearly perpendicular to the ecliptic. This is consistent with the primary direction of travel of the fast halo-CME observed at the Sun. Moreover, the NCDE and helium enrichment are consistent with the position near the streamer belt of the flaring active region NOAA 10720 associated with the CME. However, differences between interplanetary and solar observations indicate a large rotation of the erupting filament and overlying arcade, which can be attributed to the flux rope being subject to the helical kink instability.

Keywords: interplanetary medium, solar wind, icmes

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ASIV032 **Oral Presentation** **3712**

Aspects of particle acceleration and transport in inner heliosphere

Dr. Gang Li
IAGA

Zank, G. P., Verkhoglyadova, Olga P.

Particle acceleration in the inner heliosphere is best seen in impulsive and gradual solar energetic particle (SEP) events. In these events, energetic particles (protons and heavy ions) are accelerated either in flares (presumably a reconnection site) or at propagating CME-driven shocks, reaching energies as high as ~1 GeV/nucleon. One active research in space physics today is to understand the acceleration mechanism of these particles and their transport in the solar wind. Observationally, a tremendous amount of data has been accumulated over the past several decades. These include those of remote sensing such as X-ray, gamma-ray, white light, UV, and radio observations and those of in-situ measurements where particle composition, time intensity profiles and particle spectra are obtained. In this talk, we focus on gradual SEP events. We will review some recent observations such as time intensity profile, time evolution of Fe/O ratio and particle anisotropy made by ACE spacecraft. We further discuss the implications of these observations on modeling. We also discuss two theoretical aspects of shock acceleration, namely how shock geometry and upstream turbulence will affect the acceleration process and the particle energy. These theoretical considerations are helpful in interpreting observations of particle data obtained in situ at 1 AU.

Keywords: cme driven shock, particle acceleration

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ASIV032 **Oral Presentation** **3713**

Development of three-dimensional MHD model of the solar wind-interplanetary space combining system

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Existing global models of the solar-wind/IMF expanding to the Earths orbit are basically grounded in the idea of source surface. It is widely accepted that the sector structure and the solar wind speed are primarily controlled by the magnetic field at the source surface and the so-called expansion factor. On the other hand, 3-D MHD model is still off from practical use because both of scientific and technical problems. One of the former problems is the reproduction of supersonic solar-wind. From the viewpoint of the physics of the solar wind, coronal heating and outward acceleration mechanisms are invoked to explain the supersonic evolution of the solar wind. Since the mechanism responsible for the heating/acceleration is still one of the primary subjects of the physics of the solar wind, many MHD models have taken into account their effects by incorporating additional source terms corresponding to promising candidates such as thermal conductions, radiation losses and wave pressures. However there are few MHD models considering or testing the effects of the expansion factor, which determines the solar-wind speed in the series of source surface models.In this study we newly incorporate the flux tube expansion rate into the MHD equation system including heat source function in the energy equation. Appling the unstructured grid system, we achieved the dense grid spacing at the inner boundary, which enable us to adopt realistic solar magnetic fields, and a size of simulation space of 1AU. Photospheric magnetic field data is used as the inner boundary condition. The simulation results are summarized as: (1) The variation of solar wind speed is well controlled by the structure of magnetic fields at and little above the solar surface and (2) Far above the solar surface, the interface between high and low speed flows evolves to a structure suggestive of CIRs. Comparing the data from simulation with the actual solar wind data obtained by spacecrafts, we discuss the future improvement of our model.

Keywords: solar wind, modeling, mhd

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ASIV032 **Oral Presentation** **3714**

The Education and Public Outreach Program for IHY

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"Demonstrate the beauty, relevance and significance of Space and Earth Science to the World" - this IHY basic objective is the focus of the Education and Public Outreach (EPO) Program. There are unique opportunities for expanding the education and awareness of heliospheric science during IHY, making the education program a cornerstone of IHY.Here we give an overview of the IHY EPO Program. We describe its goals, structure, components, plans and what have already been achieved.

Keywords: heliosphere, education, solar system

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ASIV032 **Oral Presentation** **3715**

IHY Campaign Plans for 2007-2009

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NASA GSFC NASA GSFC IAGA

Richard Stamper

The IHY has established a set of primary scientific objectives and goals. To accomplish these goals, a wide range of Coordinated Investigation Programs (CIPs) will transpire throughout the IHY timeframe, driving towards a more complete understanding of heliophysical universal processes. The CIPs are the basic "building block" of IHY science - they are proposed by members of the IHY community, and are approved and coordinated by the IHY discipline coordinators. The aim is that the program remains under the control of the proposer(s) with the IHY CIP process providing a means of publicising the proposed work, co-ordinating access to and use of the necessary resources, and a forum for discussing the results. This presentation will review CIP plans, the CIP management system, the CIPs currently active within IHY, and progress towards a global heliosphere campaign featuring all participating IHY instruments and modelers.

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ASIV032 **Oral Presentation** **3716**

Electron Acceleration at Collisionless Shocks

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Energetic electrons are a common feature of interplanetary shocks and planetary bow shocks, and they are invoked as a key component of models of nonthermal radio emission, such as solar radio bursts. A simulation study is carried out of electron acceleration for high Mach number, quasi-perpendicular shocks. Two dimensional self-consistent hybrid shock simulations provide the electric and magnetic fields in which test particle electrons are followed. A range of different shock types, shock normal angles, and injection energies are studied. When the Mach number is low, or the simulation configuration suppresses fluctuations along the magnetic field direction, the results agree withtheory assuming magnetic moment conserving reflection with only modest electron energy gains. For high Mach number, with a realistic simulation configuration, the shock front has a dynamic rippled character. The corresponding electron energization is radically different: Energy spectra display:(1) considerably higher maximum energies than Fast Fermi acceleration; (2) a plateau, or shallow sloped region, at intermediate energies 2 - 5 times the injection energy; (3) power law fall off with increasing energy, for both upstream and downstream particles, with a slope decreasing as the shock normal angle approaches perpendicular; (4) sustained flux levels over a broader region of shock normal angle than for adiabatic reflection. All these featuresindicate that dynamic structure in the shock surface at ion scales produces effective scattering and can be responsible for making high Mach number shocks effective sites for electron acceleration.

Keywords: particle acceleration, shock waves

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ASIV032 **Oral Presentation** **3717**

Identification and support of outstanding astronomy students

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The aims, organizational plan and syllabus of a specialized Astronomy School with a subject of training students for participation in the International Astronomy Olympiad are devoted to the International Heliophysical Year. Thematic frame includes basic educational activities during the preparation and self-preparation of the students and their participation in astronomical Olympiads. A model of identification and selection of outstanding students for astronomical Olympiads has been developed. Examples of didactic systems of problems for development of mathematical, physical and astronomical skills are shown. The programme ends with individual training for solving problems on astronomy and astrophysics. Possibilities, which the characteristic, non-standard astronomical problems give for stimulating the creative and original thinking, are specified. Basic psychological condition for development of the students creative potential transformation of the cognitive content in emotional one is demonstrated. The programme of identification and support of outstanding students on astronomy is realized in collaboration with The Ministry of Education and Science, Public Astronomical Observatories and Planetaria, Institute of Astronomy Bulgarian Academy of Sciences, Solar-Terrestrial Influences Laboratory BAS and The Union of Astronomers in Bulgaria.

Keywords: astronomy olympiad, astronomy school, creative activity

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ASIV032 **Oral Presentation** **3718**

What does Long-term Geomagnetic Activity tell us about the Sun?

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Geomagnetic activity results from the interaction of the solar wind and the heliospheric magnetic field with the Earths magnetic field. Geomagnetic activity has been monitored continuously for more than 160 years. Long-term geomagnetic activity depicts certain patterns and periodicities, the most dominant of which are the solar 11-year variation and the semiannual variation. Other significant fluctuations include the annual variation, 1.3-1.8-year variations and the 22-year variation. Moreover, the overall level of geomagnetic activity has increased during the last 100 years although the exact amount of increase is still debated. All of these variations reflect some fundamental properties of the Sun and the Sun-Earth connection. Although some of the above mentioned patterns and periodicities are known for a long time (e.g., the semiannual variation for nearly 150 years), the understanding of their connection with the Sun has been significantly improved recently. Here I will review the above mentioned properties in long-term geomagnetic activity and discuss the present understanding of their solar cause.

Keywords: geomagnetic activity, solar change

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ASIV032 **Oral Presentation** **3719**

Education and public outreach activities in Bulgaria devoted to the celebration of the IHY

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Yuri Gagarin Public Astronomical Observatory and Planetarium (PAOP) and SolarTerrestrial Influences Laboratory of the Bulgarian Academy of Sciences (STIL BAS) will focus on the following: Whole the year: Lectures and Observations: Astronomy for everybody February March: Lectures on Astrophysics (6 lectures at the Art Gallery, Stara Zagora), announcement of the Competition We and the Sun for paintings and photographs, for students in three age groups 7-10, 11-15, and 16- 20 years old. April: Lectures Cosmos near and remote and astronomical observations devoted to April 12 World Day of Astronautics, Yuris Night World Space Party on April 12, 2007, and April 23 World day of Astronomy May 4: Public presentation of the IHY Programme lecture, exhibition of paintings and photographs won at the Competition We and the Sun, press conference June: Open Doors Day on June 10, 2007, Summer Solstice festival municipal competition The Sun our nearest star July: Municipal Summer school of Astronomy for students, formulating problems for the National Astronomy OlympiadSeptember: Lectures devoted to pre-historic monuments and cults connected with the Sun considered as a God in the Antiquity October 4: Celebration of the 50th anniversary of the First launch of an artificial satellite of the Earth in CosmosNovember: National competition of science fiction tale Stara Zagora 2007 devoted to the Day of the National Leaders 1st November

Keywords: ihy, education, public outreach

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ASIV032 **Oral Presentation** **3720**

Heliospheric distribution of the solar EUV flux over the latest solar cycle

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ASIV032 **Oral Presentation** **3721**

Abundances in the solar wind

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Solar matter provides information on the initial composition of the solar nebula, from which differentiation processes led to the formation of planetary objects, including planets, comets and parent bodies of meteorites. The Sun is also the endpoint of a long nucleosynthetic evolution, beginning with the Big Bang, and processing by many generations of stars, leaving their imprint in the final composition of protosolar matter. The solar wind is the most direct source of information on the isotopic composition of the Sun. However, the observed variability of isotopic and elemental abundances indicates that no 1:1 correlation between solar wind and solar composition exists. Correspondingly, inferences from solar wind composition to solar composition require a comprehensive understanding of the processes, which lead to the variably fractionated solar wind abundances. Recent missions yield a somewhat ambiguous picture of this variability. A preliminary analysis of the Genesis samples, which were exposed to different solar wind regimes, indicates that the solar wind is isotopically rather homogeneous, confirming the picture obtained from the Apollo Foil Experiments. On the other hand, in situ mass-spectrometry of the in-ecliptic solar wind has yielded the picture that its composition is highly variable on comparably short time scales and also varies substantially in different solar wind regimes, e.g. in solar wind emanating from coronal holes or from the equatorial streamer belt. We discuss recent results, we will mention possible impacts of systematic and statistical uncertainties in the in-situ observations and comment on some proposed models of fractionation processes.

Keywords: solar wind, composition

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ASIV032 **Oral Presentation** **3722**

The international heliophysical year: an overview

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Joseph M. Davila, Barbara J. Thompson

The International Heliophysical Year (IHY) is a program of international collaboration to address fundamental global questions of Earth and space science. The goals of the IHY are to: 1. Develop the basic science of heliophysics through cross-disciplinary studies of universal processes. 2. Determine the response of terrestrial and planetary magnetospheres and atmospheres to external drivers. 3. Promote research on the Sun-heliosphere system outward to the local interstellar medium - the new frontier. 4. Foster international scientific cooperation in the study of heliophysical phenomena now and in the future. 5. Preserve the history and legacy of the IGY on its 50th Anniversary. 6. Communicate unique IHY results to the scientific community and the general public. The IHY helps us develop a deeper understanding of physical processes in the solar system through a program of comparative study of universal processes that affect the interplanetary and terrestrial environment. The IHY goals will be achieved by addressing four key elements: Science, instrument development, history preservation, and public outreach. Science will be done based on a series of observing campaigns being developed as the Coordinated Investigation Programs (CIPs). The instrument development program is a cooperative activity between the United Nations and IHY to deploy low-cost instruments in developing nations that provide important data on space science. The history preservation is being accomplished by compiling information on scientists who worked during the famous 1957 International Geophysical Year (1957-58) and recognize them during 2007-2009. The outreach program is a worldwide effort to demonstrate the beauty of and benefit of space science to the general public. This presentation reviews the current status of worldwide IHY efforts.

Keywords: ihy heliospace, unbss, small instrument arrays

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ASIV032 **Oral Presentation** **3723**

Observational constraints for solar particle acceleration

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Energetic particles from suprathermal to occasionally relativistic energies are produced in various circumstances in the corona, from apparently quiescent active regions to large flare and CME events. The Sun is a unique astrophysical site where we can study energetic particle populations both remotely and by in situ measurements, and where we can image the regions where these particles are accelerated. The hard X-ray and gamma-ray imaging with RHESSI, in situ measurements with ACE and Wind, and ground-based observations with a suite of spectrographic and imaging radio telescopes have brought a wealth of new information in recent years that will be discussed in this review : the acceleration of electrons and ions during flares, where RHESSI showed to the surprise of many distinct interaction regions of these particles; the refined pieces of evidence that magnetic reconnection plays a key role in the acceleration during flares; and the intriguing findings on the complex interplay of CMEs and flares in the acceleration of particles that escape to space, which challenge a clear distinction between « shock-accelerated » and «flare-accelerated» particle populations.

Keywords: solar, acceleration, rhessi

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ASIV032 **Poster presentation** **3724**

Studies of the Energy Spectra of incident cosmic radiation by the networks of particle detectors

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Ashot Chilingarian

There are numerous indications that particle acceleration took place in supernovae remnants, by pulsars, super-massive black holes, in the galaxy clusters and by stars. As a universal mechanism operated on different scales the stochastic and shock acceleration is pointed. It is very important to use our nearest star the sun, as laboratory in studying particle acceleration phenomena. The surface particle detectors, along with space-born spectrometers are capable of detecting solar particles in the energy range from KeVs till several Tens of GeV. The large surface arrays are detecting particle in energy range from ~100 TeV till EeV. This reachness of information on particle fluxes on different scales can be used in studing physical processes responsible for particle acceleration in Universe. Surface detectors measuring Extensive Air Showers (EAS) initiated by Primary Cosmic Rays (PCR) incident on terrestrial atmosphere have been in operation since the last 50 years with main goal to explore the major enigma of Cosmic Ray (CR) origin and acceleration. Recent achievements of the Atmospheric Cherenkov Telescopes and X-ray space laboratories, establishing the supernova remnants (SNRs) as source of hadronic cosmic rays pose stringent conditions on the quality of the EAS evidence. After establishing the existence of the knee in all particle spectrum the most pronounced result from EAS studies is the rigidity dependent shift of the knee position to the highest energies. This feature first observed by the exploiting the separation of the primary beam in different groups of mass in MAKET-ANI, EAS-TOP and KASCADE experiments also pointed to the SNR blast shocks as CR source. The MAKET ANI detector is placed on mountain Aragats (Armenia) on 3200m at see level (40.50N, 44.20E). More than 1.3106 showers with size greater than 105 were registered in 1997-2004. The detector has effectively collected the cores of EAS, initiated by primaries with energies of 51014 - 1017eVResults from the MAKET-ANI experiment on the energy spectra of the light(p+He) and heavy (O+Si+Fe) nuclear groups are compared with spectra obtained by balloon experiments, as well as with other available EAS spectra.

Keywords: cosmic ray eas energy spectra

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ASIV032 **Poster presentation** **3725**

Advanced Date Acquisition System for the SEVAN (Space Environmental Viewing and Analysis Network)

Dr. Suren Chilingaryan

Ashot Chilingarian, Varuzhan Danielyan, Aram Yeghikyan

For the reliable and timely forecasts of dangerous conditions of Space Weather world-wide networks of particle detectors operate at different latitudes, longitudes and altitudes. Based on new type of hybrid particle detectors developed at ASEC (Aragats Space Environmental Center) in the context of the International Heliophysical Year (IHY 2007) we start to prepare hardware and software for the first sites of SEVAN (Space Environmental Viewing and Analysis Network) particle detectors network. In the paper presented the architecture of the newly developed DAS (Data Acquisition System) for the SEVAN. We plan to run SEVAN network under one-and-the same DAS, enabling fast integration of data for on-line analysis of Solar Energetic Events in progress. The ADAS (Advanced Data Acquisition System) is designed as a distributed network of the uniform components connected by means of web service interfaces. Its main component is URCS (Unified Readout and Control Server) server which controls the underlying electronics by means of the detector specific drivers and makes a preliminary analysis of the on-line data. The lower level components of URCS servers are implemented in pure C and the fast binary representation is used for the data exchange with electronics. However, after preprocessing the data is converted to the self-describing hybrid XML/Binary format and from that point the system components are implemented on a high level of abstraction and the web service interfaces are used for the data interchange. To achieve better reliability all URCS servers are running on embedded minicomputers without moving mechanical parts. The data storage is carried out by means of two high performance servers working in parallel which are periodically inquiring the data from all URCS servers and storing it in MySQL database. The implementation of control interface is based on the high level web standards and, therefore, all properties of the system can be remotely managed and monitored by the operators from internet browsers. The ADAS at ASEC in Armenia is in operation from November 2006. The reliability of the multi-client service was proved by continuous monitoring of neutral and charged components of incident cosmic ray flux with 7 particle monitors located at 2000 and 3200 meters above sea level on the distance of 40 and 60 km. from the main data server.

Keywords: data acquisition, space weather, detector networks

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ASIV032 **Poster presentation** **3726**

Electromagnetic spectrum monitoring in the frequency range of 10 240 mhz at the Brazilian Southern Space Observatory - a radio-quiet site potential for IHY-2007 installation of instrumentation

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Characterization of electromagnetic interference originated from natural or anthropogenic radio frequency sources is essential information to evaluate the radio noise level and the site quality in order to study the possibility for installation of sensitive radio astronomic instrumentation at the Southern Space Observatory SSO/CRS/INPE-MCT (29S, 53W), in So Martinho da Serra, RS, Brazil. The monitoring of the Electromagnetic Spectrum in the frequency range of 10 240 MHz has been carried out at the SSO - Observatory since 1992. The radio interference data acquisition is carried out by an integrated system of: omnidirectional antenna, amplifier, spectrum analyzer and controlling computer, which is used to control the spectrum analyzer and for data storage. The omnidirectional antenna is installed outside at the Observatory and the detected radio signals are transmitted via coaxial cable to the amplifier system. After the amplification procedure, the signals are processed and digitalized by the spectrum analyzer. The data communication between the spectrum analyzer and the computer is made by a GPIB interface. For a remote controlling of the data flux, reduction and analysis, the data are sent via TCP/IP Protocol (Internet) to the Southern Regional Space Research Center CRS/INPE MCT, in Santa Maria, RS, Brazil. The todays observed datawas analyzed andwas compared with the results and analysis of the observed local electromagnetic spectrum at the SSO Observatory since 1992. The results indicate no significant variations of the site noise quality and of the interference level on the local electromagnetic spectrum for the last 15 years. From the observations of the systematic monitoring of radio interference one may say that in southern Brazil there is a very good radio-quiet site potential for IHY-2007 installation of sophisticated and sensitive passive radio instrumentation for Space Science, Aeronomy - for radio propagation monitoring with RIONETERs, SAVNET - South America VLF NETwork and UHF, or for low frequency Radio Astronomy, similar to LOFAR stations, at the Southern Space Observatory SSO/CRS/INPE-MCT, in So Martinho da Serra, Brazil, RS.

Keywords: radio interference, site potential, ihy2007 radio instrumentation

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ASIV032 **Poster presentation** **3727**

Multi-Cultural Adaptations of International Heliophysical Year (IHY) Education Resources: A Perspective of a Developing Country.

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The world is made up of people of varied cultures who speak different languages. In Africa and, to be more specific, in Nigeria, there are a wide diversity of languages and customs. Nigeria has over 200 ethnic social units, to the extent that just a few of the populace have an effective understanding of English, the nations official language. Hence, most communications are carried out in the local languages. In order to efficiently communicate the heliophysical and other scientific and technological phenomena to the general public, quite a lot would have to be done in the cultural and language context. In a nutshell, there would be a need to adequately involve the social scientists in the education and public outreach programs relating to space science and technology. This paper would therefore attempt to look at various ways in which languages and diversity in cultures could be harnessed more effectively to communicate science. The paper would also discuss how the various International Heliophysical Year education resources would be adapted to a multi-cultural society, therefore, able to reach all the people in the world.

Keywords: developing countries, spoe, multicultural adaptaions

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ASIV032 **Poster presentation** **3728**

Space Weather Monitors for the IHY 2007: Distributing Scientific Instruments and Classroom Materials Worldwide

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Deborah Scherrer, Morris Cohen, Todd Hoeksema, Umran Inan, Ray Mitchell, Philip Scherrer

Earth's ionosphere reacts strongly to the intense X-ray and ultraviolet radiation released by the Sun during solar events and by lightning during thunderstorms. Stanford's Solar Center in conjunction with the Space, Telecommunications and Radioscience Laboratory and local educators have developed inexpensive Space Weather Monitor instruments that students around the world can use to track and study these changes to the ionosphere. Through the United Nations Basic Space Science Initiative (UNBSSI) and the IHY Education and Public Outreach Program, our monitors are being deployed to high schools and universities in up to 192 countries. Our project directly supports the IHY by developing global understanding of the response of the terrestrial atmosphere and magnetosphere to terrestrial and extraterrestrial drivers. Through our educational component, we hope to inspire the next generation of space and Earth scientists and spread the knowledge of our solar system and the exciting process of scientific exploration to the people of the world! We will describe the monitors themselves, supporting classroom materials and research suggestions, the development of a centralized database and communications hub, student access to Scientist Mentors, and translation of materials for IHY distribution.

Keywords: education

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ASIV032 **Poster presentation** **3729**

Comparing waiting time distributions of Bs and AE extreme events

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Roberto Bruno, Bruno Bavassano

The aim of the present work is to perform a statistical study on the waiting time distributions of BS (north-south turnings of the interplanetary magnetic field) and AE (that reflects the auroral response to the solar wind forcing) for different phases of the solar cycle. For a turbulent process, we expect the waiting-time distribution to follow a power-law behavior. In fact, since turbulence may be viewed as a fragmentation process that transfers energy from large to small scales, we expect to find long range correlations between structures generated at different scales. On the contrary, for a stochastic process, events are not correlated and, consequently, we expect to find a Poissonian distribution. In this work, we focus on extreme events of BS and AE since we believe that the physical mechanism which drives the solar wind-magnetosphere coupling reaches the highest efficiency during this kind of events. It is important to study extreme events since they strongly affect the statistics, especially the small scales distributions. In fact, their occurrence is higher than that that they would have if they were normally distributed and, consequently, they dominate the tails of the distribution itself. These events appear as coherent, isolated fluctuations with a typical lifetime longer than that of the stochastic fluctuations surrounding them. In order to select extreme events, a technique, called local intermittency measure (LIM), based on wavelet decomposition, is used. Thus, we can measure the waiting time between consecutive events and build the relative distribution. Our study highlights similarities between the waiting time distributions of BS and AE and, in particular, shows the power-law nature of these distributions which clearly suggests the existence of long term correlations among the events. Moreover, we find that these distributions do not depend on the particular phase of the solar cycle considered.

Keywords: turbulence, coherent structures, wavelet decomposition

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ASIV033 **3730 - 3743**

Symposium
Neutral-plasma interactions for planets, moons, asteroids, and comets

Convener : Dr. Christian Mazelle

This session will be a forum for presenting recent progress in the space plasma physics of solar system bodies without measurable dynamo magnetic field. The interaction of Mars with the solar wind is mainly of the atmospheric type like Venus but with strong modifications of the local ionospheric structure by the crustal fields. Their exosphere makes these planets also share common physical processes with comets. The interaction of Titan with the fast co-rotating plasma inside the magnetosphere of Saturn is another example of such interaction in a different parameter range. The session will be in particular devoted to new results from Mars Global Surveyor and Mars Express at Mars (e.g., Martian aurorae), from Cassini around Saturns moons including Titan, Enceladus, Rhea and others, and expected results from Venus Express. Paper relating to Rosetta's Mars flyby are also encouraged. Numerous open issues include upstream waves, plasma boundaries and their dynamics, atmospheric and ionospheric escape, influence of Martian crustal fields, etc. Recent results in data analysis and theoretical results, including numerical simulations are encouraged. Papers related to forthcoming space missions (including Rosetta and New Horizons) or future projects are also welcome.

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ASIV033 **Oral Presentation** **3730**

Individual and Synergistic Effects in Substaining Exospheres at Icy Satellites

Dr. Raul Baragiola
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The exospheres around icy satellites and rings are determined by the interactions of magnetospheric particles, solar photons, and neutral atoms and molecules with the surface. Our laboratory studies the relevant processes: sputtering, photodesorption, gas adsorption and desorption from ices and their role in altering the surface composition. We will report on newly observed radiation effects on water-ammonia ices that may contribute to the water and nitrogen plumes at Enceladus, and on the discovery of the synergistic effects such as radiation-assisted adsorption and the burial of radiolytic products by redeposition of water. These effects can be of primary importance, calling for a re-evaluation of the interactions between icy bodies and their environment.

Keywords: enceladus, magnetosphere, icysatellites

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ASIV033 **Oral Presentation** **3731**

Magnetometer observations from Venus Express

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Zhang Tielong, Mag Team

The launch of Venus Express provides a new opportunity to study the solar wind interaction with Venus. For the present solar minimum conditions, we find that the bow shock stands off from the planet a smaller distance than at solar maximum. On the dayside, the magnetic field piles up to form a magnetic barrier in the inner magnetosheath. The magnetic barrier (an induced magnetosphere on the dayside) is bound by the ionopause at its lower boundary and a magnetopause at its upper boundary. Both ionopause and magnetopause extend to the nightside. The magnetopause on the nightside separates the magnetosheath and magnetotail which is formed by the anchored, draped magnetic fields. In contrast to its unmagnetized state at solar maximum, the ionosphere now appears to be completely magnetized and its upper boundary, the ionopause, significantly lowered. The magnetic draping configuration on the dayside becomes reverse draping on the night-side, forming a near toroidal magnetic field at low altitude. Furthermore, the magnetometer data show the presence of different wave types upstream of the bow shock. The classical waves generated by particles backstreaming from the bow shock are seen within the foreshock region. Also, proton cyclotron waves (PCWs) are observed upstream of the bow shock, both outside and inside the foreshock region, proving pick-up of hydrogen from the planetary exosphere already far from the planet (~ 3 Rv). Such upstream PCWs were observed at Mars, but not yet at Venus. From the MAG data we have a direct proof that the solar wind is removing hydrogen from a large volume around the planet; this may have an important effect on the evolution of the Venus atmosphere.

Keywords: solar wind interaction, upstream waves

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ASIV033 **Oral Presentation** **3732**

The structure and variability of Titan's magnetic environment

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Nicholas Achilleos, Karoly Szego, Andrew J. Coates, Jan-Erik Wahlund, Christopher S. Arridge, Fritz M. Neubauer, Christian Mazelle, Ronan Modolo, Michele K. Dougherty, David Young, William Kurth

The recent plasma observations obtained by the Cassini spacecraft around Titan have revealed that its interaction with Saturn's magnetosphere is more complex than initially thought. In tis work we analyze Cassini magnetometer and plasma data to characterize the plasma environment encountered by Titan along its orbit and the structure of its 'induced magnetosphere'. First, we find that the properties of the plasma upstream from Titan (background magnetic field, plasma density, temperature, flow direction) are strongly dependent on the proximity of the moon to Saturn's magnetodisk. Second, Cassini magnetometer data near Titan reveal the presence of regions of weak and strong magnetic field draping likely associated with an outer weak and an inner strong strong massloading region respectively. The region characterized by a strong draping is in fact the satellite's 'induced magnetosphere' and it is enclosed by a magnetic pileup boundary as seen at Mars, Venus and comets.

Keywords: titan, draping, massloading

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ASIV033 **Oral Presentation** **3733**

Replacement of Solar-Wind flow by planetary

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Andrei Fedorov, Jean-Andr Sauvaud, Christian Mazelle, Stas Barabash

When the solar wind encounters an atmosphere of a non-magnetized planet,a void of the solar wind is created. This void, also known as "inducedmagnetosphere", is filled by accelerated ions of planetary origin.The shape of such voids around and behind Mars and Venus was investigatedby early missions mostly by magnetic measurements. Nowadays with adequateion spectrometers in plasma packages Aspera-3 and Aspera-4 onboardof Mars Express and Venus Express respectively, we can provide a finestructure of transition region from the particles point of view. Thepresent work is completely based on the IMA mass-spectrometer dataonboard of both spacecrafts. We have performed a statistical studyof solar-wind ions and planetary ions spatial distributions in thevicinity of the transition region between solar-wind flow and inducedmagnetosphere. We used a special reference frame associated with experimentalmagnetospheric boundary to plot the average parameters of ions flow.We found that magnetosheath velocity profile starts to deviate fromgasdynamic model far from magnetospheric boundary and a sudden sharpdecrease of the solar-wind flux associated with the appearence ofaccelerated O^{+} and O_{2}^{+} planetary ions. Correspondingion parameters profiles have been compared for Mars and Venus magnetospheres.

Keywords: mars, venus, magnetosphere

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ASIV033 **Oral Presentation** **3734**

Ion morphology of the martian and venusian magnetotails

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IAGA CESR CNRS

Clair Ferrier, Stasbarabash, Tielong L. Zhang, Jean-Andre Sauvaud, Christian Mazelle

The wakes of Mars and Venus are filled by accelerated ions of theplanetary origin. Spatial distribution of such ions together withdraped interplanetary magnetic field creates a character elongatedtail-like structure. The cross-section of such a tail consists oftwo lobes filled by low energy plasma, separated by a thin currentsheet, associated with rather intense flow of accelerated ions (plasmasheet). The general construction of the martian tail is similar tovenusian one, but the morphology of different ion species is quitedifferent. This paper presents a study of the fine ion structureof the martian and venusian tails based on the data from IMA massspectrometer (Aspera-3/4) aboard of Mars Express and Venus Expressmissions. The flow of different ion species was investigated in aspecial frame referring to the magnetic field direction. Epoch superpositionanalysis shows that the central plasma sheet, coinciding with zeroBX is filled by heavy ions like O+ only. The He+ions discovered in the martian tail as well as in the venusian tailcreate an envelope of plasma sheet, and this helium layer is surroundedby a thick proton sheet. The paper compares the scales of these layersat the both planets and discusses the reason of such a stratification.

Keywords: venus, mars, magnetosphere

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ASIV033 **Oral Presentation** **3735**

Field-aligned currents, parallel electric field potentialdrops and aurora on Mars

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Fraenz, M., Woch J., Chanteur G., Winningham J. D., Frahm R., Lundin R., Barabash S.

The observations of the electron inverted 'V' structures by the MGS and MEX spacecraft, their resemblance to similar events in the Earth' auroral regions, and the discovery of strong localized magnetic field sources of the crustal origin on Mars, suggested the existence of Martian aurora produced by the electron acceleration in the parallel electric fields. Following the theories of such type of structures on Earth we perform a scaling analysis to the Martian conditions. Due to much smaller magnetic fields, as compared to the Earth case, the ionospheric Pedersen conductivity is much higher on Mars and the electric fields are strongly reduced. Auroral field tubes with parallel potential drops and relatively small cross scales to be adjusted to the scales of the localized crustal patches may appear only at the nightside. On the other hand, fluxes of suprathermal electrons (Ee ~30-100 eV), which could be sources of aurora-type emissions on Mars, are spatially well organized and form narrow strips in regions bounding patches with strong upward and downward vertical components of the crustal magnetic field. We present observations of both type of electron distributions, statistics of their appearance, and discuss possible mechanisms of aurora-type emissions.

Keywords: mars, aurora, magnetosphere

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ASIV033 **Oral Presentation** **3736**

New results from Mars on crustal field electron signatures and on Venus-like electron holes

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Dr. Andrew J. Coates, Dr. David Winningham, Dr. Ruday A. Frahm, Dr. Rickard Lundin, Dr. Stas Barabash

Mars and Venus are both believed to have lacked a magnetic field of internal origin for most of their histories [1], [2], & [3], leaving the upper atmosphere unprotected from scavenging by the solar wind. The interaction of the solar wind at these unmagnetized bodies is thought to have played a role in the atmospheres evolution at each planet.The Electron Spectrometer (ELS) on Mars Express. Analyser of Space Plasmas and Energetic Atoms (ASPERA-3) has been providing new information on the solar wind interaction at Mars for the past three years. One such result is observations of irregular signatures over magnetized regions of the Martian crust [4] where the local plasma either begin to intensify or deplete significantly, possibly providing enhanced atmospheric loss at those locations. We report on statistics of new signatures recorded between 2004 and 2006, and on new analysis of altitude dependence of the electron behaviour. Comparisons of the first observations by Mars Express of electron holes at Mars over non-magnetic regions of the crust, with observations of ionospheric holes at Venus by Venus Express. ASPERA-4 ELS. will provide a view of aspects of the solar wind interactions which are similar at each planet. References, [1] Acuna, M. H., et al., Global Distribution of Crustal Magnetization Discovered by the Mars Global Surveyor MAG/ER Experiment, Science, 284, 790 - 793, 1999, [2] Curtis, S. A. and Ness, N. F., Remanent magentism at Mars, Geophysical Research Letters, 15, 737 - 739, 1988, [3] Stevenson, D. J., Planetary magnetic fields, Reports on Progress in Physics, 46, 555 - 620, 1983 & [4] Soobiah, Y., et al., Observations of magnetic anomaly signatures in Mars Express ASPERA-3 ELS data, Icarus, 182, 396 405, 2006.

Keywords: mars, venus, solar wind

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ASIV033 **Oral Presentation** **3737**

Oxygen ionization rates at Mars

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ASPERA-3 observations onboard Mars Express carried out during several years provided us with maps of plasma environment of Mars. Oxygen ion production rates in the near-Mars space for photoionization, charge exchange and electron impact ionization are evaluated on the base of statistical survey of electron and proton fluxes, and recently measured altitude profiles of neutral hydrogen and oxygen. These values give us a conservative estimate of escape rates induced by solar wind. The results are compared to models and direct observations of oxygen fluxes.

Keywords: mars, escape, magnetosphere

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ASIV033 **Oral Presentation** **3738**

Capture of solar wind alpha-particles by the Martian atmosphere

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R. Modolo, E. Dubinin, M. Fraenz

Integration along He++ test-particle trajectories in the self-consistent electromagnetic fields generated by three-dimensional hybrid simulations of the solar wind/Mars interaction is used to evaluate the losses of solar wind alpha-particles due to charge-exchange processes. Approximately 30% of solar wind alpha-particles impacting the planetary crosssection are transformed into single-ionized and neutral helium, that corresponds to a total loss rate of He++ ions equal 6.71023 s−1. The flux of helium neutral atoms, created by double electronic capture on exospheric oxygen, impacting the exobase, and penetrating below where it can be trapped, is about of 1.51023 s−1. This implies an important role of the solar wind source in the helium balance of the Martian atmosphere. The implantation of the solar helium on Mars shows an asymmetry related to the orientation of the motional electric field of the solar wind. −VSWBIMF .

Keywords: mars, helium, numerical simulation

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ASIV033 **Oral Presentation** **3739**

Pickup Ion Phase Space Distributions at Titan: Effects of Atmospheric Spatial Gradients

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Edward Sittler, Jr.

The composition and structure of neutral exospheres imbedded in moving plasmas can be determined by measurements of the velocity distributions of their pickup ion progeny. In turn, the velocity distributions are dependent on the spatial structure of the neutral source gases. Since Titans neutral exosphere extends into the Saturns magnetosphere (or solar wind) and well above its ionopause, it serves as a good place to analyze such characteristics. They are analyzed using pickup ion measurements made by the Cassini Plasma Spectrometer (CAPS) at Titan [e.g., Hartle et al., 2006] and an ion kinetic model. The model [Hartle and Sittler, 2007] is an expression describing the phase space density of pickup ions, which is derived from the Vlasov equation with an ion source that explicitly accounts for the velocity and spatial variation of the exosphere source gases. A fundamental parameter in the phase space density expression is the ratio of the gyroradius to the neutral scale height., $\alpha = rg/H$. Titans exosphere includes H, H2, CH4 and N2, with scale heights near the exobase of ~ 2400, 1200, 149 and 85 km, and αs of ~ 0.1, 0.4, 27, and 82, respectively. This structured exosphere yields pickup ions whose phase space distributions are beam-like when $\alpha >> 1$ and fluid-like when $\alpha << 1$. Downstream from the source peak, the light pickup ions, with $\alpha << 1$, are easily observed because the phase space density is almost uniform over the orbit phases. On the other hand, the phase space distribution of the heavier ions, with $\alpha >> 1$, peaks over a narrow velocity and spatial range. This beam-like nature makes it more difficult to observe the heavy ions because the downstream positions and viewing directions are narrowly constrained. Examples of these extremes will be discussed.Hartle et al., Planet. Space Sci., 54, 1211, 2006.Hartle and Sittler, J. Geophys. Res., in press, 2007.

Keywords: pickup ions, phasespace, titan

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ASIV033 **Oral Presentation** **3740**

VEX Insight on the Boundary Separating Solar and Planetary Plasmas Around Venus

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Data obtained by the ASPERA-4 experiment onboard the VEX spacecraft are presented. The main plasma regimes around the planet are discussed from ions, electrons and magnetic field measurements. The inner region Venusward of the magnetosheath is characterized by a sharp decrease of solar wind ions and the appearance of high fluxes of heavy planetary ions. Closer to the planet, CO2 photoelectrons sign the entry inside ionosphere proper. On the base of these particle and field data we discuss the formation of the boundary separating solar and planetary plasmas.

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ASIV033 **Poster presentation** **3741**

The peculiarities of the solar wind interaction with Mars from the Phobos 2 mission data

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The experimental facts contradicting the standard point of view on the interaction of Mars with the solar wind are examined with the use of the data of the Phobos 2 satellite. It is necessary to note that the Phobos 2 expedition is unique during which the simultaneous measurements of the magnetic field and the plasma parameters near to Mars were acquired. Besides, the value of the data is that there is the longest uniform set of data obtained on circular orbits at 2 radiuses of Mars. The experimental facts are established which specify that Mars itself represents an obstacle to the solar wind as the physical body with processes of the dispersion. It is ascertained that at the 2 radiuses of Mars the perturbed magnetic field in the Mars wake is directly proportional to the density of the ambient solar wind plasma. It is necessary to point out the same dependence from the velocity is absent. There is the dependence of the occurrence and disappearance of the magnetic field depressions in the wake from the direction of the interplanetary field. The standard representations about the Mars interaction with the solar wind as a comet-like or a magnetosphere-like are at variance with the same experimental facts. It is found that if the plasma density exceeds a critical value of order 1--2 cm-3 the effect of the accumulation of the solar wind plasma ahead of the Martian obstacle is observed. The occurrence of the magnetic pillow points to the solar wind with the density lower than 1 cm-3 interacts with the Martian atmosphere directly.

Keywords: solar wind interaction, mars, phobos 2 mission

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ASIV033 **Poster presentation** **3742**

Plasma interaction with Venus, Mars and Titan: similarities and differences

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Yasir Soobiah, Chris Arridge, Rudy Frahm, David Winningham, David Young, Stas Barabash, Rickard Lundin, Ed Sittler, Karoly Szego, Dick Hartle, Aspera-4 Team, Aspera-3 Team, Caps Team

Venus, Mars and Titan are unmagnetized objects immersed in plasma flows. At Venus and Mars the upstream region is the solar wind (with different parameters) while at Titan the upstream region is Saturns (almost) corotating magnetosphere. Here we present data from the ASPERA-4 and 3 and the CAPS Electron Spectrometers, with ion data for context as appropriate, to examine the similarities and differences between the interactions with the upstream plasma flow. At Venus and Mars we see bow shocks, sheath plasma and ionospheric plasma including ionospheric photoelectrons. At Titan we see a mass loading region and ionospheric plasma including ionospheric photoelectrons and, at times, negative ions. We compare the observed structures of the plasma interaction regions and the plasma populations in each case.

Keywords: venus mars, titan, plasma

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ASIV033 **Poster presentation** **3743**

Ion distributions and associated low frequency waves in the upstream region and foreshock of Venu

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S. Barabash, T.L. Zhang

We present the analysis of energetic ion distributions in the solar wind upstream from the bow shock of Venus as measured by the IMA mass spectrometer (Aspera-4) onboard Venus Express. Backstreaming ions produced by a reflection process at the bow shock surface and populating the foreshock are clearly observed both in the quasi-perpendicular and the quasi-parallel parts of the Venusian foreshock, the later clearly associated with large amplitude ULF waves. Similarities and differences with the observations in the terrestrial ion foreshock are discussed. Proton ring-like distributions are also observed in the upstream region of Venus. Their association with waves at the proton cyclotron frequency reported from the magnetometer data are discussed.

Keywords: venus, bow shock, foreshock

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ASIV034 **3744 - 3747**

Symposium
Reporter Reviews

Convener : Prof. Iver Cairns

This session contains reviews of recent advances, both theoretical and observational, on the Sun, solar wind, and heliosphere. Given by active researchers, these reviews will cover a comprehensive range of topics in a manner that is accessible to researchers from other IAGA Divisions, while offering synthesis and context to Division IV scientists. All talks in this session are by invitation only.

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ASIV034 **Oral Presentation** **3744**

Advances In Magnetic Turbulence And Particle Acceleration In The Corona And Solar Wind

Prof. Gary Zank
IGPP University of California IAGA

An outstanding problem in space physics is to explain the origin of energetic particles (solar energetic particles, impulsive and gradual events, etc.) throughout the heliosphere. Considerable progress has been made on this problem. In the late 1970s, a suite of papers was published establishing the idea of diffusive shock acceleration for cosmic rays, essentially a first-order Fermi mechanism, which appeared to provide an explanation for the observed cosmic ray spectrum up to the knee. Diffusive shock acceleration is probably the most widely used particle acceleration mechanism in astrophysics and space physics, yet the theory is based on some stringent simplifications. The detailed [plasma] physics of the acceleration mechanism requires elucidation, in particular the close coupling of the magnetic turbulence responsible for scattering the particles, the possible excitation of the turbulence by the energetic particles themselves, and the role of shock obliquity with respect to the upstream magnetic field. We are fortunate in that very detailed observations of particle acceleration at shock waves, particularly in the guise of Space Weather, are providing considerable experimental insight into the basic physics of particle acceleration at a shock wave. Indeed, understanding the problem of particle acceleration at interplanetary shocks is assuming increasing importance, especially in the context of understanding the space environment. Detailed interplanetary observations are not easily interpreted in terms of the simple original models of particle acceleration at shock waves. Three fundamental aspects make the interplanetary problem much more complicated than the typical astrophysical problem: the time dependence of the acceleration and the solar wind background; the geometry of the shock and the character of the magnetic turbulence; and the long mean free path for particle transport away from the shock wave, again a consequence of the nature of the turbulence in the interplanetary medium. An interplanetary shock is not steady as it decelerates and expands into an expanding, temporal solar wind. Furthermore, the shock geometry varies from quasi-parallel to quasi-perpendicular along a shock front, with important implications for the turbulence responsible for scattering particles at the shock front. Consequently, the shock itself introduces a multiplicity of time scales, ranging from shock propagation time scales to particle acceleration time scales at parallel and perpendicular shocks, and many of these time scales feed into other time scales (such as determining maximum particle energy scalings, escape time scales, etc.). We will discuss the basic physics of particle acceleration via scalings, their relationship to particle acceleration and magnetic turbulence models, observations and geometry in both an astrophysical and space physics context. This will include discussing the physics of perpendicular and parallel shocks, upstream turbulence, particle spectra, and particle injection and the seed population. After acceleration of particles at an interplanetary shock, the transport of energetic particles is non-diffusive because of their large mean free path in the quiet solar wind. The complications of coupling diffusive (at the shock) to non-diffusive transport will be addressed. In particular, we will address the coupled acceleration and transport of heavy ions, Fe/O ratios, the variability among individual events, and seed particle populations. We will discuss theoretical models and address recent modeling efforts.

Keywords: particle acceleration, turbulence

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ASIV034 **Oral Presentation** **3745**

Solar flares and the magnetic field near active regions

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Recent progress of both observational and theoretical studies of solar flares and the magnetic field near active regions will be reviewed, with emphasis on studies in recent 4 years. In the last year, Hinode and STEREO satellites were successfully launched and we are now again in a golden age of solar physics research. Very new findings from these new missions (especially Hinode) will also be reviewed.

Keywords: observation, solar physics

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ASIV034 **Oral Presentation** **3746**

Coronal mass ejections in the corona and solar wind

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In this review, I present an overview of the past few years of research that has contributed to a significant enhancement in our understanding of coronal mass ejections (CMEs). The uniform and extended data on CMEs that became available over the past ten years has greatly contributed to the current understanding in the areas of CME initiation, propagation through the interplanetary medium, and impact on geospace. After summarizing the morphological, physical, statistical properties of CMEs, and phenomena associated with them, I present an overview of the current issues in CME initiation. Accompanying phenomena such as shocks, interplanetary CMEs, and solar energetic particles and radio bursts provide information the broader consequences of CMEs. Interaction of CMEs with the global solar magnetic field of the Sun leading to the magnetic cloud structure in the interplanetary space will also be briefly reviewed. Finally, I discuss CMEs in the heliosphere including the out-of- the-ecliptic observations from Ulysses.

Keywords: cmes, interplanetary cmes, geospace consequences

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ASIV034 **Oral Presentation** **3747**

Recent advances in shock studies in the corona, solar wind, and planetary bow shocks

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V. Lobzin

This paper reviews the significant advances made in recent theoretical and experimental studies of collisionless shock physics. Collisionless shocks were intensively studied experimentally in the near-Earth environment aboard satellites (Cluster, ISEE, AMPTE, Wind, Polar and many others), in interplanetary space, in the vicinity of other planets (Cassini, Galileo, Ulysses, and Voyager), and on the boundary of the heliosphere (Voyager), as well as by means of remote sensing techniques making use of radio observations of the Sun (SOHO and Wind). Radio observations play an important role as a diagnostic tool for following the propagation of CMEs in interplanetary space. Also, fast and slow blast waves are assumed to be related to the Morton and EIT waves propagating on the surface of the Sun from reconnection sites. Planetary bow shocks, as well as a number of shocks in the solar wind and solar corona, are high-Mach-number shocks. From the very beginning of collisionless shock studies it was found that there exists a set of critical Mach numbers corresponding to abrupt modifications of the front structure, including transitions from stationary behavior to nonstationarity. Several theoretical studies and computer simulations of high-Mach-number shocks showed that there can exist a shock front instability that leads to a dynamic behavior of shocks. Later this phenomenon was called reformation of the shock front structure. For oblique shocks, the reformation was found to be related to the conditions for existence of the standing whistler wave train within the front. Computer simulations of high-Mach-number shocks in two-dimensional geometry led to the discovery of large-scale “ripples,” which move on the shock surface. Such new instability can result in appearance of additional mechanisms for energy dissipation and particle acceleration. The Cluster satellites give a possibility to use in situ observations of collisionless shocks as a natural laboratory to study the fundamental processes of shock front dynamics. Multi-point measurements, which provide a unique opportunity to distinguish between spatial and temporal variations, allow one to identify different types of phenomena such as “ripple” structures. Recent results show clear manifestations of nonstationary behavior and reformation of Earth’s bow shock.

Keywords: collisionless shock physics, solar wind

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ASV035 **3748 - 3791**

Symposium
The role of magnetic observatories in monitoring and modeling Earths magnetic field

Convener : Dr. Jean-Jacques Schott
Co-Convener : Dr. Pieter Kotze

Magnetic observatories specialize in measuring the long-period changes in the field while at the same time providing one-minute or sub-minute sample data for studies of rapid variations. Over the years, the types of users of magnetic observatory data and the uses to which they put the data have changed. In addition, a large amount of data now comes from satellite surveys. How have these changes affected the role of magnetic observatories? What impact will the changing requirements of the user community and the availability of data from satellites or other sources have on ground magnetic observatories? We welcome contributions that examine these questions from all points of view, such as the type of data required by the user, the coordination of observatories and other ground magnetometers with satellite and other campaigns, and the types of instruments required to produce the data.

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ASV035 **Oral Presentation** **3748**

Reason of the North and South Magnetic Poles drift

Prof. Vladimir Kuznetsov
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IASPEI

The drift velocity of North magnetic pole has increased about five times through the last 20 - 30 years. What is a reason of this phenomenon: a usual cyclic process causing a stop of a pole in 2140, or the effect of Jerk-69, or a start of the geomagnetic field reversal? Since 1860 both North, and South magnetic poles are drifting towards each other along the paths peculiar to the drift of virtual magnetic poles during reversal. Candidate reasons accounting for the poles drift acceleration are discussed. It is shown, that the North magnetic pole location in the nearest 3-5 years will help to answer this question.

Keywords: magnetic poles, drift, acceleration

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ASV035 **Oral Presentation** **3749**

Observatory contributions to regional reference field models in the Satellite ERA - the australian experience

Dr. Adrian Hitchman
IAGA

Andrew Lewis

Throughout most of last century charts of the geomagnetic field in the Australian region were historically derived solely from regional observatory and repeat-station data. More recently, the Australian Geomagnetic Reference Field (AGRF) model uses observatory, repeat station, satellite, airborne and ground based vector data sets to derive spherical cap harmonic models of the main field and its secular variation in the Australian region. Notwithstanding the inclusion of these large data sets, observatory and repeat station data remain central to the development of both the main-field and secular-variation models that comprise the AGRF. This paper will discuss the continuing reliance of the AGRF models on observatory and repeat station data and will describe the importance of these data in developing a global spherical-harmonic model of secular-variation used to update to epoch the data sets used in the derivation of the AGRF main-field model Despite the fact that observatory data now represent less than 1% of all data used to derive the AGRF, the record of secular variation they provide remains the foundation on which the model continues to be based.

Keywords: geomagnetism, observatories, models

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ASV035 **Oral Presentation** **3750**

Geomagnetic field of the Republic of Macedonia 2003 2004

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Todor Delipetrov, Blagoj Delipetrov

Field measurements included observation of the total vector of the geomagnetic field F, declination D and inclination I. Measured data were corrected with the data from neighboring observatories Panagiuriste, Republic of Bulgaria; Pendeli, Republic of Greece and Aquila, Republic of Italy and Tihany, Hungary. According to the measured data in 2003 and 2004 maps of all components were made. Isolines of the geomagnetic elements were drawn with the Surfer program package. The coefficients for normal geomagnetic field on this territory were calculated. Comparing measured values with the same points in IGRF2000 model, values for F component, declination D and inclination I can be correlate.

Keywords: geomagnetic field, declination inclination, geomagnetic observatories

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ASV035 **Oral Presentation** **3751**

Establishing geomagnetic observatory and net of repeat stations on the territory of the Republic of Macedonia

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Blagica Doneva, Todor Delipetrov

After the independence of the Republic of Macedonia, team from the Faculty of Mining and Geology in Stip, in the period of 10 years, make efforts for establishing geomagnetic observatory and net of repeat stations. In the period from 2002 to 2007, in cooperation with the Royal Meteorological Institute - Geomagnetic observatory in Dourbes, Belgium, series of geomagnetic measurements were carried out in the Republic of Macedonia. The net of repeat stations was set up and the location for the observatory was selected. It is on Mt. Plackovica. Thanks to the close collaboration with the observatory in Dourbes, the staff for observatory work was retrained. Within the Tempus Project "Geomagnetic measurements and quality standards" the equipment for the observatory was purchased. According the territory, the net of 15 repeat stations was made. All stations satisfy the criteria for local gradient (horizontal and vertical) of the geomagnetic field.

Keywords: geomagnetic measurements, geomagnetic observatory

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ASV035 **Oral Presentation** **3752**

Geomagnetic field models for Southern Africa during 2005 - 2006

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Geomagnetic field observations over southern Africa, including countries like South Africa, Namibia, and Botswana, were conducted during October November 2005 as well as 2006 as part of a collaborative project, called COMPASS (COmprehensive Magnetic Processes under the African Southern Sub-continent) between the Hermanus Magnetic Observatory (HMO) in South Africa and the GeoForschungsZentrum Potsdam (GFZ) in Germany. For this purpose some 40 repeat stations were identified, separated by distances ranging from 300 till 400 km. These stations form part of a network of 75 repeat stations, established by the HMO during the last 60 years, and visited at regular intervals of 5 years till 2000. Due to the rapid secular variation change over this area, annual surveys were conducted between 2000 and 2004 at a reduced number of 12 repeat stations. This did however not allow for good spatial resolution, hence the increased number of stations in 2005 and 2006. Results obtained from these field surveys, together with information from the 3 continuous recording magnetic observatories in southern Africa at Hermanus, Hartebeesthoek and Tsumeb, have been used to model the main geomagnetic field as well as its secular variation. Results obtained by modelling the declination for 2005 over southern Africa revealed an extremely steep spatial gradient, ranging from almost 26 degrees west of true north in the southern part, to almost 10 degrees west of true north in the northern part. In comparison to previous field surveys, this pattern is indicative of a growing gradient in the orientation of the geomagnetic field of southern Africa in a north-west, south-eastern direction. The dynamic variation of the magnetic field as observed in southern Africa necessitates a dense array of suitable ground-based observations for this region with field surveys conducted at regular intervals, preferably on an annual basis.

Keywords: geomagnetic, field, models

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ASV035 **Oral Presentation** **3753**

A seismological task for geomagnetic observatories

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Continuous recording at geomagnetic observatories serves mainly to study phenomena associated with the geomagnetic dynamo, with solar-terrestrial processes, with the magnetosphere. Additionally, observatory data are indispensable reference values for geomagnetic surveys. But do observatories eventually provide essential data related to seismicity and to the geodynamic performance of the Earths crust, too? The presentation is going to indicate an application of routinely recorded geomagnetic field values at observatories for seismological purposes. The basis for this novel considerations are results which have been obtained in studies performed in the past 10 years, at the Central Institute of Meteorology and Geodynamics, Vienna, and in co-operation with many geophysical institutes worldwide: Geomagnetic variations in three time ranges, daily, seasonal and in the long term, are closely related to the changes of seismic activity in almost every earthquake region, which has been studied so far. The data of observatories within a distance of 100s km and even more than 1000 km have been used for this analyses. The starting point for the investigations in 1996 was the fact, that seismic activity exhibits a clear and systematic variation with time of day, that is, with local time (e.g. Conrad, 1932; Shimshoni, 1971; Duma, 1996). In the past, the few attempts to interpret this observation were without success. But any dependence on local time logically indicates an external sun related process which exerts a powerful influence on the dynamics of the Earths crust. Basic forces of external origin, which act on the Earths lithosphere, are of course the tides. But numerous studies reveal that tides can not be considered a basic and general source that triggers earthquakes. So, what else does? It was the astonishing observation of an obvious synchronous performance of geomagnetic variations and regional seismic activity (Duma 1996; Duma and Vilardo, 1998) which led to the hypothesis of a magnetic or electromagnetic mechanism that links both processes, even if this does not seem reasonable from the energetic point of view. An answer to these confusing observations has then been given by a quantitative model of telluric currents in the Earths lithosphere (Duma and Ruzhin, 2002) which accompany all the geomagnetic variations in all time domains, according to the Maxwell equations. The model indicates the generation of mechanic forces (Lorentz forces) due to the telluric currents and a resulting mechanic moment, the amount of which is comparable to that one caused by tectonic deformation itself. Observational results are shown for several main earthquake zones in Europe, Asia and N-America and they are compared with the results of the model, which simulates this Magneto-Seismic Effect for the geomagnetic diurnal variation (Sq) and the secular variation.

Keywords: geomagnetic variations, seismicity

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ASV035 **Oral Presentation** **3754**

Development of fluxgate magnetometer with ring-core for South Atlantic magnetic anomaly sama monitoring

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Nelson Jorge Schuch, Josemar De Siqueira, Sandro Fettermann Bertagnolli, Fagner Chagas Rother, Nalin Babulau Trivedi

The Geomagnetic variations study and data acquisition can provide important information about the Magnetosphere, the Earth/Sun interaction, as well as Ionospheres events occurrences which can, for instance, generate disturbances in telecommunications or even in the space whether. Specially in the area where is observed the lowest intensity of the Earths magnetic field in the Global surface, the South Atlantic Magnetic Anomaly SAMA, where frequently occurs larger scales events, mostly because the great particles precipitation in the form of magnetic storms, due to the low magnetic field intensity. To improve the knowledge and the understanding of the Earths Magnetic Field behavior in the SAMAs area it has been developed a fluxgate magnetometer with ring-core in the Southern Regional Space Research Center CRS/INPEMCT in the south of Brazil. The magnetometer has its operation based on the iron magnetic properties of the high permeability ring-core. Varying the magnetic permeability of the nucleus through a high frequency excitation signal it is possible to obtain a response that changes the magnetic saturation around the nucleus as in the (BxH) Histereses curve. The sensor coil detects a signal with high harmonic content which is related with the Earths Magnetic Field in the observation region. This paper has the intention to show the way used to implement the sensor, the electric circuit and specially the preliminary data and conclusions about experiments performed at the Southern Space Observatory - SSO/CRS/INPE MCT which is located near the center of the SAMA in Brazil.

Keywords: geomagnetism, fluxgatemagnetometer, amas database

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ASV035 **Oral Presentation** **3755**

San Fernando magnetic observatory (SFS): new site and improvments

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The Royal Naval Observatory (ROA) started its first absolute observation series at ROA headquarters in 1879, but a continuous time recording would not begin until 1891. From then onward an almost continuous recording of the magnetic components was developed. At late seventies the railway electrifying induced a very important interference that obliged to move to another site in 1978 (SFS second phase) located 10 km far away, NE, from the previous site. During the nineties the magnetic station kept in operation, but environmental noise made difficult to fulfil a higher level on precision required by international organizations like INTERMAGNET. On 2004, SFS move to a new site located about 60 km NE from its first emplacement. From then onward it has been active, keeping the older observatory (SFS second phase) in operation until January 2006. At Fall 2006 SFS joined the global network of magnetic observatories INTERMAGNET. This communication will present this new observatory; summarize results gathered during its first three years operation: Data quality, baseline and future operating plans.

Keywords: magnetic observatory

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ASV035 **Oral Presentation** **3756**

Spherical Harmonic Analysis of data from magnetic observatories poorly covered the globe.

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Using the assumption that the errors of observatory data are random and the secular variation fields in the space do not correlate with a random data set, it has been indicated that the nonuniform distribution of observatories on the Earths surface is not an insuperable hindrance in construction of spatially uniform models of the main geomagnetic field and its secular variations. Several test calculations, where the satellite model and the series of random numbers were used as a true field value and deviations, respectively, have been performed. It has been indicated that the spherical harmonic models constructed based on noisy data are equal to the sum of true and noise models. In this case the series of noise models constructed based on independent samples do not correlate with one another and with a true model. Assuming invariancy of the spatial power spectrum the last one was chosen as a regulating parameter in the spherical harmonic analysis. Normalized in this way, SH coefficients formed new model with new misfit of original data. A few itterations gave us sufficiently good description of SH coefficients.

Keywords: spatially uniform models, errors of observatory data

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ASV035 **Oral Presentation** **3757**

Global dynamics of storm associated magnetic pulsations based on the ground observations

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Several magnetic superstorms occurred in October and November 2003, November 2004, May 2005 with Dst-index as great as 350-400 nT. Very intense magnetosphere substorms (up to 3000 nT) and night-time irregular geomagnetic pulsations in the frequency range of 1-10 mHz (Pi2 and Pi3 types) accompanied the main phase of these storms. The dynamic spectra of the magnetic pulsations from more than 100 ground-based stations were computed and the frequency range of the most intense oscillations was established. The global maps of the amplitudes of the pulsations in the obtained frequency band distribution, computed for the given UT storm interval, were used for study the temporal location of the most intense pulsation generation area in the coordinates: geomagnetic latitude- local geomagnetic time (LAT-MLT map). To study the spatial-temporal dynamics in the different MLT sectors the magnetic keogrames (LAT-UT diagrams), similar to well known optical aurora keogrames, were computed by using the ground data from several meridian chains such as IMAGE, Greenland network, 210 meridian stations. The obtained results demonstrate the different spatial-temporal pulsation dynamics during the different storms. Both poleward as well as equwatorward shift of the pulsation area generation was observed.

Keywords: pulsations, superstorm

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ASV035 **Oral Presentation** **3758**

The development and role of geomagnetic observatories in Indonesia

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Geomagnetic observations in Indonesia have been carried out and developed by Badan Meteorologi dan Geofisika (BMG), and started in 1866 during Dutch colony era for the study of terrestrial magnetism. The first observatory was conducted at Batavia (Jakarta) and moved to Bogor, Kuyper and Tangerang respectively. In the last ten years there have been a lot of improvement of the geomagnetic observations conducted by BMG, especially the improvement of equipments from analog to digital system. BMG has developed two new geomagnetic observatories at Kupang and Pelabuhan Ratu. The Kupang observatory is located in the region of the Nusa Tenggara Timur (NTT) Province is aimed to observe the geomagnetic phenomena along the most southern hemisphere of eastern Indonesian region. In the mean while, the Pelabuhan Ratu Geomagnetic Observatory will take over the observations at Tangerang Observatory which has been contaminated with the local disturbances such as electric railway and other developments of the Tangerang town. Pelabuhan Ratu is located in the West Java Province, about 150 km southward Jakarta. At present ,BMG has already operated (three) geomagnetic observatories, Tangerang, Tuntungan (Medan) and Tondano (Manado),and will be operating two new observatories ,i.e : Kupang (NTT) and Pelabuhan Ratu. The role of geomagnetic observatories in Indonesia is to provide data services to the institutes dealing with navigation, communication, mapping and geophysical research. Finally, based on this capacity BMG is planning to be accepted amongst the best observatories in the world, and being seen as an active and respected member of the global geomagnetic community.

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ASV035 **Oral Presentation** **3759**

The role of geomagnetic field measurements in monitoring the magnetospheric dynamics.

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Continuous worldwide measurements of the geomagnetic elements at high resolution (1 min or less) are important for investigating several aspects of magnetospheric dynamics (driven by the modulation of the solar wind pressure and by variations of the orientation of the interplanetary magnetic field), as well as for discriminating the role of the magnetospheric and ionospheric current systems on ground variations. We discuss the importance of such measurements for a definite identification of interesting elements such as sudden impulses, generation and propagation paths of external waves, and the possible occurrence of cavity modes of the entire magnetosphere. In addition, measurements with a time resolution of the order of 1s allow to investigate the occurrence of standing waves whose frequency depends on the plasma distribution along field lines. In this case the availability of geomagnetic measurements at small latitudinal separation (1-2) along the same meridian provides an useful method for determining the variations of the plasmaspheric mass density.

Keywords: magnetosphere, impulses, diagnostics

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ASV035 **Oral Presentation** **3760**

A comparative analysis of geomagnetic, magnetospheric and interplanetary observations of long period oscillations at discrete frequencies

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The power spectra of the geomagnetic field components often reveal a clear tendency for a repeated occurrence of spectral enhancements approximately at the same frequencies (f 1.2-1.4, 2.1-2.3, 2.5-2.7, 3.2-3.4 mHz). Comparative analysis of the geomagnetic field measurements at several ground stations with simultaneous magnetospheric and interplanetary observations are important for understanding origin and propagation of the observed fluctuations. We discuss two case events which presented an unprecedented one-to-one correspondence between interplanetary, magnetospheric and ground measurements in terms of frequency, onset and duration of wave packets at f 1.0, 1.3, 2.2 and 3.2 mHz. It suggests that geomagnetic fluctuations can be directly driven by density fluctuations of the solar wind at the same frequencies by modulation of the magnetopause current. We also discuss the possible occurrence of additional contributions related with cavity/waveguide resonances of the entire magnetosphere as well as those of resonance processes of geomagnetic field lines.

Keywords: magnetosphere, pulsations

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ASV035 **Oral Presentation** **3761**

The achievements of geomagnetic observations and studies in Egypt since the IGY 1957

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The paper is concerning with the geomagnetic studies done by the national research institute of astronomy and Geophysics, Egypt during the last five decades (1957-2007). The paper shows three main arguments: (a) the erection of 2 new magnetic observatories (b) the performance of 5 successive geomagnetic surveys of Egypt that resulted in the production of corresponding magnetic charts, and (c) The trends of the scientific researches. The charts and the main results of the scientific work are shown.

Keywords: observatory, geomagnetism, egypt

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ASV035 **Oral Presentation** **3762**

The role of magnetic observatories: the observatory operators perspective.

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Individual magnetic observatories are part of a global scientific observing infrastructure monitoring the state of the geomagnetic field and, through analysis of the data provided, giving information on the dynamic processes that cause it to change over a wide range of time scales. There is no doubt that the high-quality long-term datasets provided by observatories have contributed to many scientific discoveries. In addition, observatory data are used in the production of global geomagnetic field models and magnetic activity indices used routinely in both scientific research and practical applications. Among the factors that influence the success of observatory operations, as measured by data utilization, are relevance to scientific questions and real-world problems, and the accessibility and ease of use of data. The question of relevance is a function of data attributes such as resolution and sampling rate as well as quality. The modern observing environment includes other ground based magnetometer networks set up for specific purposes, and satellite surveys able to produce datasets with near-global coverage rapidly. The role of magnetic observatories in relation to these other sources of geomagnetic field data needs to be clear. Observatory operators must keep under review the needs of existing and new users of observatory data and also be aware of those who benefit from the data either directly or indirectly. Effective communication between the supplier and user communities is essential. The present-day challenges to magnetic observatory operations, and the attempts made to address some of them in a co-ordinated manner through the INTERMAGNET programme, will be discussed in the light of the issues raised above.

Keywords: magnetic observatories, geomagnetic field modelling, geomagnetic field monitoring

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ASV035 **Oral Presentation** **3763**

The role of ground-based measurements for modelling the magnetic field at regional scales

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The magnetic observatories have always played a key role in the global modelling of the Earths magnetic field. Since the advent of the satellite era, their role is less notorious but continues to be central. Thanks to the satellite missions and joint international efforts to compile airborne measurements, we now have an opportunity to represent the lithospheric magnetic field at high resolution from ground to satellite altitudes. This paper addresses the ubiquity of observatory measurements in this context. In addition to the large panel of applications offered by observatory data, it will be shown how magnetic observatories contribute to the lithospheric magnetic field modelling by: constraining models at the ground surface, offering a mean to select datasets, reducing repeat station measurements, monitoring and detecting second-order magnetic field signals, and identifying global transient effects. A few recent results based on regional modelling techniques and satellite data processing will be discussed. They illustrate and quantify the role of observatory data, especially in the framework of high resolution modelling.

Keywords: r scha, lithospheric field

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ASV035 **Oral Presentation** **3764**

The Modeling Earths Magnetic Field and the Evolution of the South Atlantic Magnetic Anomaly (SAMA).

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The Earths Magnetic Field representation by means of mathematical models dates since year1650, with a coefficients of spherical harmonical analysis development to order 6 for that epoch. From the establishing of Pilar Magnetic Observatoy in year 1905, are available data from magnetic observatories in the SAMA region. The present work analyzes the results of the Definite Geomagnetic Reference Model (DGRF) from 1945 to 2000 year, and Inetrnatiornal Geomagnetic Reference Model (IGRF) 2005. The results of the DGRF 1945-2000, IGRF 2005 and from the Network of Magnetic Digital Observatories: Las Acacias (LAS), Vassouras (VSS), Trelew (TRW), Hermanus (HER), Huancayo (HUA) and classical magnetic observatory Pilar (PIL), shows that in the region of Rio de La Plata is located the minimun of SAMA, with a secular variation rate in the order of -40 nT/year registered in LAS, wich is comparatively more negative than the other observatories and specialy for those of -21 nT/year calculated in VSS. This work concludes that in the next decades the total magnetic intensity will continue minimizing and the SAMA will continue expanding, producing colateral effects in the surface modulated by the space weather of the Sun-Earth conection.

Keywords: sama, earth magnetic field, observatory

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ASV035 **Oral Presentation** **3765**

Towards an improvement of the geomagnetic observatory network

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To map the Earth's magnetic field for both spatial and temporal variations, data from various platforms (ground observatories, repeatstations, special surveys over land and sea, and satellites) are mainly used. During the last years, efforts have been made by different agencies to measure the Earth's magnetic field from space. Orsted, SAC-Cand CHAMP will be followed by the ESA mission Swarm, planned for 2010. Meanwhile, efforts have also to be done to improve the ground observatory network. Recently, GeoForschungsZentrum (GFZ) Potsdam has been strongly involved in installing new observatories or upgrading existing ones.An overview of observatories run by GFZ is given. GFZ involvement currently includes besides Niemegk the existing observatories Wingst(Northern Germany) and Panagjurishte (Bulgaria) and the newly installed ones at Villa Remidios (Bolivia) and Keetmanshoop (Namibia). In 2007 three more observatories are planned to be upgraded: Yakutsk and Magadan (Russia), and Hyderabad (India), and a new one to be installed on Saint Helena island. In this contribution we will show that only improving the quality and distribution of the observatory network, the satellite data can be fully used in order to study the short scale variations in the Earth's magnetic field.

Keywords: geomagnetism, observatories

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ASV035 **Oral Presentation** **3766**

Investigation of the 2003 geomagnetic jerk using worldwide observatory hourly mean data

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An examination of observatory data is made in order to search for evidence of the geomagnetic jerk occurring at beginning of 2003 and found from an analysis of satellite data (Olsen and Mandea, 2006). Observatory hourly mean values are carefully selected around 2003 and years of similar, previously accepted, earlier jerks, and are processed in a consistent way in order to extract the jerk signal. The year 2003 is fairly disturbed compared to years of earlier jerks and an initial examination of observatory data highlighted the difficulty of extracting the latest jerk signal in such conditions. We examine whether it is possible to sufficiently reduce the effects of these external fields in single observatory data series by using data selection techniques and eigen-analyses. The alternative approach is to do a global analysis in order to characterise the large-scale external field but this can only be done some time after the event and ideally when satellite data are available. Quality control issues in the observatory hourly mean values highlighted by this work are also discussed. Olsen, Nils and Mioara Mandea, 2007. Investigation of a secular variation impulse using satellite data: The 2003 geomagnetic jerk, Earth Planet. Sci. Letts., 255, 94-105.

Keywords: jerks, geomagnetism, observatories

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ASV035 **Oral Presentation** **3767**

The role of magnetic observatories in the geophysical researches in Vietnam

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Le Truong Thanh, Ngo Van Quan, Nguyen Thanh Dung

Nowadays, a large amount of magnetic data comes from satellite surveys. These data are very precious to the studies of Earths magnetic field. However, the data obtained from magnetic observatories remain always indispensable in monitoring and modeling Earths magnetic field, especially in the geophysical researches in Vietnam. Vietnam has now a system of four magnetic observatories: Chapa, installed from 1957, which will be celebrated 50th jubilee this year 2007, Phu Thuy, installed from 1967, which become MPO from 1993, Da Lat, created in 1981 and Bac Lieu, built from 1988. These observatories have a very big importance, contributing very much not only to the monitoring and modeling Earths magnetic field, but also to the geophysical application problems in Vietnam: - Theyre indispensable in the reduction processing of repeat station network data to a certain epoch, in the case of a territory elongated, irregular and near to the equatorial region likes Vietnam, where the diurnal magnetic variations are very complicated and cover a large range; - Now the observations of the magnetic fields on the territory of Vietnam in the surveys of research and exploitation of the useful minerals, of the geological disasters, serving to the construction of the big projects as hydro power-plant, nuclear power-station are developing strongly on the territory of Vietnam in order to satisfy the requirements of economical, social developments of our country. For all these, the data from magnetic observatories are very necessary; - Thanks to the magnetic observatories, we could study the problem of impact of the magnetic storms on the system of 500kV power lines system; - Thanks to the magnetic observatories, we could obtained important results in the study of corrosion caused by magnetic variations on petrol and gas pipe-lines system in Vietnam. These results were informed to the Petro-Vietnam to take measures to protect the pipe-lines. By this, one shows that GIC are a source of problems to technological systems (electric power transmission systems, oil and gas pipelines, telecommunication cables, railway equipment) not only in auroral regions, but also very strong in the low-latitudes ones.

Keywords: repeat station network, requirements of economical de, impact of magnetic storms

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ASV035 **Oral Presentation** **3768**

Experiments on the DIDD instruments to find the source of its temperature dependence

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In the course of the development of the newest DIDD model we tried to change the materials applied in the coil supporting shells and as well as in the suspension system. The goal was to decide whether a change in these materials could cause a significant alteration in the temperature dependence of the instrument. The experiments were carried out in the non-magnetic temperature test hut of the Tihany Geophysical Observatory of Etvs Lornd Geophysical Institute, Hungary. In this hut the temperature can be varied within a wide temperature range (-10C--50C) in a controlled way, applying both heating and cooling. In the same building the thermal response of an FGE type suspended fluxgate magnetometer borrowed from the DMI for temperature test was also investigated. These results, together with the results of earlier experiments yield an overview of the thermal behaviour of the widespread observatory magnetometer types.

Keywords: instrumentation, observatory

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ASV035 **Oral Presentation** **3769**

A new design for a USGS magnetic observatory

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US Geological Survey (USGS) Stennis Magnetic Observatory (BSL) at Bay St. Louis, Mississippi was destroyed during Hurricane Katrina in August 2005. In early 2006, funds were secured to reconstruct the observatory and to install infrastructure that is modern and operationally superior to the original observatory. This project is now complete and the current observatory consists of a single temperature and humidity controlled building in which absolute, variometer, and scalar intensity measurements are collected. In order to minimize interference, the air conditioning-heater system is located on a remote pad with air transported to the main building via buried pipes. Data are transported to the main office by fiber optic cable where they are then transmitted by Internet to Program headquarters in Golden, Colorado in near real time. As a backup, data are also transmitted via GOES satellite within 12 to 23 minutes of collection. This paper discusses building design and construction, and presents results obtained utilizing this new design.ASV035The role of magnetic observatories in monitoring and modeling Earths magnetic fieldnew design, magnetic observatory.

Keywords: observatory, new design

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ASV035 **Oral Presentation** **3770**

Correcting the geomagnetic IHV index of the Eskdalemuir observatory: An example of effects due to inconsistencies in early observatory data

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We study here the recently proposed measure of local geomagnetic activity called the IHV (Inter-Hour Variability) index calculated for the Eskdalemuir (ESK) station. The ESK IHV index depicts an artificial, step-like increase from 1931 to 1932. We show here that this increase is due to the fact that the values of the magnetic field components of the ESK observatory stored at the World Data Center are two-hour running averages of hourly data stored in ESK yearbooks. Two-hour averaging greatly reduces the variability of the data and leads to artificially small values of the IHV index in 1911-1931. We also study the effect of two-hour averaging upon hourly mean and spot values using 1-minute data available for recent years, and calculate the correction factors for the early years, taking into account the weak dependence of correction factors on solar activity. Using these correction factors, we correct the ESK IHV indices in 1912-1931, and revise the estimate of the centennial change based on them. The effect of correction is very significant: the centennial increase in the ESK IHV-raw (IHV-cor) index in 1912-2000 changes from 73.9% (134.4%) before correction to 10.3% (25.3%) thereafter, making the centennial increase at ESK quite similar to other mid-latitude stations. Obviously, earlier long-term studies based on ESK IHV values are affected by the correction and need to be revised. These results also strongly suggest that the ESK yearbook data should be digitized and the hourly ESK data at WDC should be replaced by them.

Keywords: geomagnetic observations

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ASV035 **Oral Presentation** **3771**

New, experimental, high sensitivity magnetic observatory installation in Mexico

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Newly installed magnetic observatory consists of Potassium dIdD and Potassium Supergradiometer. It is a byproduct of experiments in Earthquake studies that have started in 2005 after installation of Potassium Supergradiometer in Oaxaca Province of Mexico. Supergrads sensitivity of about 50fT (0.05pT) is sufficient for a short base gradiometric studies of Earthquakes. One of the obstacles of this installation is a minute difference in magnetic field direction at the three Supergrad sensors. This difference is causing invasion of diurnal changes of magnetic field into gradients between the sensors of the order of 10-30pT. High sensitivity Potassium dIdD is needed to correct for this phenomenon. The installation of the dIdD is planned for early spring 2007. and the first results are expected shortly thereafter. Potassium dIdD will measure components of magnetic field with pT sensitivity.

Keywords: observatory, earthquake, gradiometer

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ASV035 **Poster presentation** **3772**

Using neural networks to study the geomagnetic field evolution

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The neural networks have been used to study time series and predictions of different quantities that have a stochastic behavior. Considering the three components of the geomagnetic field as such quantities, we used neural networks to study their time evolution in years. Firstly, in order to find the best neural networks for the time predictions, we tested a lot of different kind of neural networks and different ways of their training that are part of MathLab software. As input and target data we used those simulated by the Gufm1-model at different places on Earth as long time series (1600-1990) of annual values of the geomagnetic field components. For the best neural networks (so called 'feed-forward back-propagation' and 'cascade-forward back-propagation' networks) a time evolution prediciton of more than 20 years with several nT accuracy was achieved, Then we used such networks to predict the values of the annual means of the geomagnetic field components beyond the time registration periods of those Geomagnetic Observatories that have long time series registrations. In order to predict a time evolution of the global field over the Earth, we considered annual means of 105 Geomagnetic Observatories, chosen to have more than 30 years registration and been well distributed over the Earth, filling out the missing values during some years (the whole time interval from 1960-2005 was chosen) by using the 'cascade-forward back-propagation networks'. We also added 139 'virtual geomagnetic observatories' in the places where real Geomagnetic Observatories were missing by using the same kind of neural networks for the same time interval (1960-2005). Then, using neural networks, we have predicted the time evolution of the three components of the global geomagnetic field beyond 2005 with accuracy that depends on the time prediction length (from 10 years prediction to 20 years prediction the accuracy goes from 10 nT to 100 nT).

Keywords: geomagnetic field model, neural network, geomagnetic field prediction

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ASV035 **Poster presentation** **3773**

Local anomalies of secular variations as the result of the main geomagnetic field sources dynamics.

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In this paper the dynamic model of sources of the main geomagnetic field is proposed. The model consists of the set of dipoles, most completely covering the spatial distribution of the main geomagnetic field for each epoch within the 100-year interval (from 1900 to 2000) with the 5-year time step. Dipoles obtained differ in magnitude within three orders and are located at different distance from the Earths center. The least powerful of them coincide at the core-mantel boundary. Local anomalies of secular variations are also considered as a result of the changes of the parameters of the least powerful sources in time. The comparative research was carried out for these dipoles to compare the time changes of the geomagnetic field components observed in a number of magnetic observatories and calculated using the model including or not the least powerful dipoles. We attempted to select for each potential source such a magnetic observatory that the local anomalies of secular variation were essentially affected by this dipole at the point of the observatory. It was found out that some local anomalies of secular variations recorded in observatories can not be explained without taking into account the dynamics of sources of the 3rd order. Besides, the formation and the decay of the same foci of the secular variation (for example, the Caspian and the Eurasian) can be completely explained by the dynamics of only one or two dipoles of the 3rd order of magnitude. Not only the dipole of the 3rd order obtained in Artic area is responsible for the local anomaly of secular variation at the point of the Dikson magnetic observatory but also it may affect the North Magnetic Poles movement. Unfortunately, the distribution of magnetic observatories on the Earth is highly irregular and the systematic measurements of secular variations are not practically taken over the World Ocean. Some marine points were set up by the non magnetic schooner Zarya. No such measurements have been carried out since then. But without the marine points of secular variations our knowledge of spatial distribution of the main geomagnetic field and its secular variations will remain incomplete. This work is supported by the RFFI grant 05-05-64181.

Keywords: secular variations

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ASV035 **Poster presentation** **3774**

The regional secular variations repeat stations network in Ukraine: the new project

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The Geomagnetic data obtained by magnetic observatories are determinant for investigation and modellingof global Earth magnetic field and its secular variations. Nevertheless, the existing World-wide Network of magnetic observatories doesnt allows to investigate the regional peculiarities of secular geomagnetic variations because of a low density of this Network. In this case a very important meaning have secular variation repeat stations (SVR). Its significant, that new opportunities for investigations of the lithosphere impact in secular variations can be obtained. It is obvious, that for such investigations it is necessary to join energies of different scientific teams from various countries. In this connection the creation of the European International Initiative MagNetE (Magnetic Network in Europe) is welcome.On the territory of Ukraine the initial SVR Network of 39 repeat stations was created in 1969-1972 years. During 1972 and 1974 there were performed two cycles of repeat component magnetic measurements. Results of these measurements have been used for anomalous magnetic field of former USSR territory maps composition for 1975 epoch. It is regretting since 1974 the measuments on this Network have not been performed thus the most of SVR were lost. That is why in 2006 in Ukraine was created the Project and were started works for renovation of the SVR Network to fulfill in the frames of this Network regular geomagnetic components observations. Accordingly with the Project in 2006 2007 is plan to establish 50 SVR with a density 1 Point in 10,000 15,000 km2. During 2006 there were settled 20 new SVR in Ukraine thereof 10 in Carpathian region. Also the modernization of magnetic observatories LVIV, KYIV, ODESA would be done. The realization of this Project allows establishing the base for monitoring of spatial-temporal Secular variations monitoring in Ukraine and get an additional information for investigation the SV on the territory of Eastern Europe.

Keywords: repeat stations, secular variations

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ASV035 **Poster presentation** **3775**

Assessment of relatively rapid changes at the geomagnetic secular variation field in Mexico from the Teoloyucan (Mexico) Geomagnetic Observatory time series

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Records, since 1952, from the geomagnetic field variations for Mexico territory are available. These records have been obtained by the National University operated Teoloyucan geomagnetic observatory (in central Mexico) and its net of reoccupation stations throughout the country. Based in this data set, preliminary isoporic charts have been compiled and the secular variation analyzed from 1952 to 1990. Accordingly, the secular variation is featured by the periods with relatively stable patterns (only minor changes observed). The periods of relatively stability span from 1952 to 1959, from 1964 to 1974, and finally from 1979 to 1990 respectively. The transitions from one state to the next operated relatively rapid about 1959, and 1974. Rapid transitions in the secular variation patterns in Japan has been reported for 1960 and 1970. In the case of Mexico, current efforts are focused to corroborate and precise the timing, and nature, of the observed rapid changes. In particular, wavelet analysis constitutes an independent method to corroborate the existence of such rapid changes. Here we present results from this wavelet analysis conducted using the continuous as well as the discrete wavelet transform

Keywords: teoloyucan magneticobservator, magnetic field changes, wave let analysis

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ASV035 **Poster presentation** **3776**

Tidal components of the geomagnetic variations

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The tidal components of geomagnetic variations generated by deformations of current contours in an external nucleus of the Earth and magnetosphere are considered. Features of geomagnetic variations with the periods of lunar tidal waves in comparison with the data of geomagnetic observatory Paratunka are discussed.

Keywords: geomagnetic, magnetosphere

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ASV035 **Poster presentation** **3777**

European geomagnetic observatories: quality and role in understanding the secular variation

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When modeling the main geomagnetic field and its secular variation over restricted regions as Europe, using the Spherical Cap Harmonic Analyses (SCHA), two major difficulties are encountered: i) data do not properly represent the magnetic field to be modeled and ii) the modeling technique presents several known drawbacks. For these reasons two detailed studies have been performed and are presented here. We first investigate the European geomagnetic observatory biases over 42 years (1960 - 2001), considering them as contributions from the crustal field, and generally constant in time. To estimate these biases, we compare observatory annual means to predictions given by the continuous CM4 model, and to four satellite-based core field models available for different epochs. Comparison of the processed data set with synthetic values given by the CM4 model, made it possible to highlight the magnetic contributions which remain in real data when only the core field estimated by CM4 is removed. A large part of the found offsets are rather constant shifts, being mainly the crustal field signature. However, long-term trends are detected for several locations, which are unlikely to originate from instrumental drift or data errors, being systematic over long time interval. Solar-cycle related external fields are clearly present in the residuals, however no suitable model to minimise them exists. To overcome this, we suggest an empirical approach to minimise these influences. Further, we apply SCHA with physical regularization to synthetic series obtained from the CM4, at 46 European observatory locations and additionally 11 'virtual observatories' chosen to improve the initial data distribution. We show that an adequate selection of model parametrisation together with the physical regularization allow that model smoothness and misfit are those required by the data themselves. Models computed for different epochs satisfy the proposed validation criteria, underlining the reliability to compute stable models over the whole considered time span. These results lead to the next step, which is a detailed study of the secular variation behaviour based on European observatory data, for which the first attemps are presented.

Keywords: observatory data, observatory biases, secular variation

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ASV035 **Poster presentation** **3778**

On the quality of geomagnetic observatory hourly means since IGY

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Long time series of geomagnetic observatorty hourly mean values are of interest for a variety of purposes, e.g. inductions studies, investigations of the time-varying external fields, and as a basis to estimate the core field and secular variation better than from monthly or annual means based on all data. Hourly means are conveniently available from World Data Centers, but particularly for older data it is mandatory to check their quality prior to using them. Less precise older devices, instrumental problems, technical or cultural disturbances but also simply errors in data transmission are the most common sources of errors in the data. Such errors often are not easily detected when an individual time series is analysed only. We are working on a project to verify all available hourly means. In a first step we had concentrated on the recent years, after 1995, and had mainly used a method of intercomparison of neighbouring observatory data to detect problems. Although many observatories had reached INTERMAGNET standard by that time, a number of problems have been detected in the files held at the World Data Center C1, Copenhagen. The detected problems have been listed in a table as reference for data users and with the request to the individual observatories to check whether the data can be corrected. Currently, we are mostly applying the method of comparing the data to predictions given by a global model and checking individual time series from 1960 to 1995. Here, we report on the progress of this project and present information on recently discovered problems in the analyzed observatory data.

Keywords: geomagnetism, observatories, hourly means

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ASV035 **Poster presentation** **3779**

New acquisition systems in French Austral Magnetic Observatories

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The more than twenty years old acquisition systems working in the magnetic observatories operated by EOST, Strasbourg, France, need a thorough update in order to meet current or desirable requirements about sampling rate, transmission facilities and ease of maintenance, motivated by scientific as well as by economic reasons. To this end, a completely new acquisition system has been developed, based upon a PC104 motherboard format, and a real-time Linux core operating system. According to most of the current long term acquisition devices, the time stamp is controlled by the GPS 1 second impulse. The main characteristics are: - simultaneous digitizing of three analog channels using three 24 bits AD converters (three components of the geomagnetic field provided by a triaxial variometer). The sampling rate is 16Hz and the data are filtered-decimated to one second using an adaptation of the Gaussian Intermagnet filter. - operating two Overhauser proton magnetometers and recording their data, at two different sampling rates, respectively 10s for the magnetometer located in the variometer house, 1 minute for the magnetometer on the absolute pier , which provides part of the absolute data. - recordings of various auxiliary parameters of interest both for controlling the sensors and acquisition environment and for facilitating the diagnostic of failures (temperatures, electronic levels for controlling the pier attitude, voltages) - twice a day automatic data transmission via email - backup of every data with an autonomy of approximately one year - remote consultation and visualization of every data A prototype version is running for several months without interruption and has proved to be reliable, easy to operate and with a user-friendly remote control. This alternative to commercial solutions has the advantage of being of relative low cost (about 7800 euros), thanks to the use of current industrial hardwares and softwares in open source.

Keywords: magnetic observatory, acquisition, real time data

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ASV035 **Poster presentation** **3780**

Isoporic modelling of the geomagnetic field components at the epoch 2005.0. Iberian Peninsula and Balearic Islands.

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The Earth's magnetic field suffer temporary variations of different periods and amplitudes. The long period variations are related to the internal origin field and receive the name of Secular Variation (SV). The SV can be separated in first approach in a temporary part and another space one. The temporary part in a station and during a short period of time adjusts to a polynomial of second degree. This variation also has a space character, reason why, if it is tried to study this phenomenon, it is necessary to determine his characteristics in the zone, from the data collected in a network of repeat stations.The achievement of the geomagnetic cartography, published by the IGN, components D, H, Z and F at epoch 2005,0, Spain Mainland and Balearic Islands, from the obtained points of map in the 1986-1993 surveys, needs the values of the coefficients of the isoporics models of each component, to be able to make the transferring of such.These coefficients are computed by two different ways. First, it consist of the resolution for each repeat station of the development of Taylor, truncating this series until second degree, surroundings to the reference station that we denominated isoporic equation. And a second method that applies the spherical cap harmonic analysis (SCHA) to a cap that sufficiently covers the zone in study. In this work, the results obtained with both methods are exposed, as well as a comparative study among them.

Keywords: icsecularvariation, scha, isoporicequation

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ASV035 **Poster presentation** **3781**

A study on the long term behavior of the impedance tensor at Nagycenk Geophysical Observatory

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In the Szchenyi Istvn Geophysical Observatory at Nagycenk, a parallel monitoring and registration of geomagnetic and telluric variations has been carried on for more than fifty years. At the first approach we started to compare the spectral energy distribution of the minute mean value horizontal telluric and magnetic components of the last four years. The impedance tensors spectra has been calculated by using four days time intervalsof thefour years 2000-2003. Based on the plane wave assumption we expected some stable behavior of the transfer function. On the contrary certain periods has been found in the time variation of some spectral component. This appeared both in the amplitude and phase of all tensor element and also the considered tensor invariants. Dominant spectral peaks has been shown at periods of 27 days and one year related to the Carrington-rotation and the Earth orbiting respectively. So as to extend our examination on longer time interval, we started to digitize the analogue telluric and magnetic records we archived since 1962. We also propose to investigate the deviation of estimated apparent resistivity curves resulting from the above variation of the impedance tensor.

Keywords: impedance, telluric, geomagnetic

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ASV035 **Poster presentation** **3782**

Comparison of daily variation characteristics at different Antarctic geomagnetic observatories and their dependence on IMF conditions

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Abstract: In this work we made a statistical analysis of the diurnal variation as observed at Antarctic observatories located in different position with respect to the polar cap. Data used are from the Italian observatory Mario Zucchelli Station (TNB; geographic coordinates: 74.7S, 164.1E; corrected geomagnetic coordinates: 80.0S, 306.8E), the French-Italian observatory Dome C (DMC; geographic coordinates: 75.1S, 123.4E; corrected geomagnetic coordinates: 88.9S, 54.3E) and the French observatory Dumont DUrville (DRV; geographic coordinates: 66.7S, 140.0E; corrected geomagnetic coordinates: 80.4S, 236.0E). In this poster we present some peculiarities of the daily variation and its characteristic and relation with the location and with Interplanetary Magnetic Field conditions. Data were also studied taking into account the different Loyd seasons. Some interesting results emerge from the analysis, confirming the dependence of the daily variation (and of the associated polar current systems), on some interplanetary parameters.

Keywords: daily variation, antarctica

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ASV035 **Poster presentation** **3783**

Propagation of ULF geomagnetic field fluctuations in Antarctica: comparison between two polar cap stations

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We conduct a statistical analysis of the coherence and propagation of low frequency geomagnetic fluctuations detected during years 2001-2002 at the two Antarctic bases Mario Zucchelli Station (TNB; geographic coordinates: 74.7S, 164.1E; corrected geomagnetic coordinates: 80.0S, 307.0E) and Scott Base (SBA; geographic coordinates: 77.8S 166.8E; corrected geomagnetic coordinates: 80.0S 326.4E), both located in the polar cap. Due to the relative position of the stations, whose displacement is essentially along a geomagnetic parallel, the phase difference analysis allows to determine the azimuthal propagation direction of geomagnetic fluctuations. The results show that coherent fluctuations are essentially detected around local geomagnetic midnight and, in a minor extent, noon; moreover, the phase difference reverses in the night time hours, indicating a propagation direction away from midnight, and also around local geomagnetic noon, indicating a propagation direction away from the subsolar point. When Interplanetary Magnetic Field (IMF) conditions are taken into account, a relation between nighttime coherent fluctuations and substorm activity emerges. Two peculiar events, characterized by quiet magnetospheric but different IMF conditions, were selected. They show clear examples of waves propagating away from the local geomagnetic noon and midnight, respectively.

Keywords: geomagnetic pulsations, antarctica

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ASV035 **Poster presentation** **3784**

Antarctic Reference Model (ARM) updated to 2006: an example of integrated use of magnetic data

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ARM is a regional reference geomagnetic model for Antarctica, proposed in its first version in 2002 and since then regularly updated. The model is based on a spherical cap harmonic analysis of ground and satellite magnetic data, the version here presented uses data from 1960 to 2006 taken over the Antarctic continent. This improved version, besides considering new available data from satellites and ground observatories, also apply a stricter procedure for decimating the huge amount of satellite data. The model can be considered valid till 2006, with predictive coefficients up to 2009. ARM is useful for the reduction of magnetic surveys over the Antarctic continent, performed during the period of model validity, for the purpose of geomagnetic anomaly field estimation. As the previous versions, also the new updated model has been tested and compared with other major global models in order to show its feasibility over the region of concern.

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ASV035 **Poster presentation** **3785**

On the 22-year variation seen in the observatory annual means of the geomagnetic field

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After eliminating solar activity related variations (Schwabe and Hale cycles effects) from annual means at geomagnetic observatories, a ~22-year variation of the main field, superimposed on a longer-term variation (a ~80-year variation plus a steady variation), is isolated and its characteristics are discussed. The variation, with amplitudes of 20-100 nT and systematic phase differences between observatories, is significant in terms of secular variation at regional and local scale and in terms of ingredients of geomagnetic jerks. The time-space evolution of the radial component of the ~22-year variation, as appears from time-longitude diagrams in the time interval 1880-1990, indicates a westward zonal movement of its maxima and minima, which can explain some of the jerk characteristics after 1980.

Keywords: geomagnetic observatory data, 22 year variation, geomagnetic jerks

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ASV035 **Poster presentation** **3786**

A new data service from the World Data Centre, Geomagnetism (Edinburgh)

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The British Geological Survey operates the World Data Centre (WDC) Geomagnetism (Edinburgh) providing access to observatory annual mean values, magnetic survey data and real-time magnetic activity indices online. In 2007 we took over responsibility for further geomagnetic datasets with the transfer of minute and hourly mean data for over 100 observatories from WDC Copenhagen to WDC Edinburgh. We present a summary of our current data service, data holdings and quality control procedures. Furthermore we illustrate how we are developing a new WDC data service using up-to-date web technologies to provide an enhanced data provision for WDC users and establish new data exchange programs with other world data centres.

Keywords: geomagnetism, observatories, world data centre

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ASV035 **Poster presentation** **3787**

Using observatory data to characterise geomagnetic daily variations

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We use data from several geomagnetic observatories to derive a series of Fourier harmonic models of the daily magnetic field variations. We form the models from datasets comprising selected numbers of International Quiet Days from each month, from different years in the solar cycle, and across a range of geomagnetic latitudes. The performances of the models are assessed by comparing their predictions with the input data. We comment on the improvement in daily magnetic field estimates over purely main field models for different seasons, solar cycle phases, and geomagnetic latitudes. In each case, we investigate how these improvements depend on the number of International Quiet Days used. Comparisons are made with the Comprehensive Model version 4; a global model that, unlike our approach, separates ionospheric sources using satellite data as well as observatory data. We comment on the relative performance of each approach.

Keywords: geomagnetism, daily variation, harmonic analysis

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ASV035 **Poster presentation** **3788**

A newly established magnetometer chain in Greece

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A new magnetometer array has been installed in recently and is operated by the Institute for Space Applications and Remote Sensing of the National Observatory of Athens. The operation of the new array has several scientific objectives: studies of geomagnetic disturbances and of Geomagnetically Induced Currents (GIC) at low latitudes, determination of the electrical conductivity structure of the lower crust and mantle, studies of magnetospheric pulsations and field line resonances, etc. We are presenting the first magnetic field data from this magnetometer chain.

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ASV035 **Poster presentation** **3789**

USGS operations at the Fredericksburg Geomagnetic Observatory a status report

Mrs. Carol Finn

Jeffrey J. Love

The U.S. Geological Survey (USGS) Geomagnetism Program currently operates 14 magnetic observatories across the United States and its territories and covering a wide range of latitude and longitude. The Cheltenham, Maryland observatory (CLH) became operational in 1900, and continued until May 1956, when it was replaced by the Fredericksburg, Virginia observatory (FRD). Together, these two observatories have provided us with a continuous record of magnetic observations for over a century. Over the years the USGS and the National Oceanic and Atmospheric Administration (NOAA) National Geodetic Survey (NGS) have shared responsibilities for geomagnetic surveys and observations, and today the two agencies share a collaborative relationship in the conduct of their respective scientific missions at Fredericksburg. The USGS is currently in the process of transferring ownership of 142 acres of Fredericksburg property to NOAA for operation of the NGS Calibration and Training Center. The USGS will retain ownership of 45 acres and most of the buildings for continued operation of the magnetic observatory. FRD continues to be an important geomagnetic observatory, providing data in near real time for use by operational space-weather programs, for the calculation of magnetic indices such as Kp, and for a variety of academic and private studies. The Geomagnetism Program is moving towards production of digital 1-second data, transported and disseminated via the Internet, at all of the USGS observatories. The Program also has an ongoing project to rescue and preserve critical historical data, important for long-term studies of the geomagnetic field and space physics. Efforts continue on facility improvements and infrastructure upgrades, something we highlight in the context of the FRD observatory. The USGS will be hosting the XIIIth biennial IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing in June 2008 at the Boulder Magnetic Observatory and Golden, Colorado. Participants will have the opportunity to see first-hand the operational improvements described here as they exist at one of our observatories and at our Program headquarters office.

Keywords: fredericksburg, magnetic, observatory

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ASV035 **Poster presentation** **3790**

Information center based on Nagycenk Geophysical Observatory (GGRI of HAS) data

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Wesztergom Viktor, Kovács Károly

Nagycenk Geophysical Observatory (IAGA code: NCK) maintained by the Geodetic and Geophysical Research Institute of Hung. Acad. Sci. was founded in 1957, in the year of International Geophysical Year. The observatory was purpose built for ground based monitoring of the Earth's environment. Measurements and reports started in the same year with earth current data. Continuous observation of atmospheric electricity and geomagnetic elements started in 1961, while ionospheric measurements began in 1967. Since 1993 Schumann resonance measurements have been carried out, and a meteorological station was installed in 1996. The observatory belonged to the INTERMAGNET co-operation since 1993, and the data are transmitted via METEOSAT satellite to geomagnetic information nodes. The yearly number of electronic citation for NCK data is approximately 3000-3500. In the frame of Regional Earth's Environment Center project (started in 2005) we offer a wider accessibility to NCK data by formation of a virtual observatory (www.reec.hu portal). The forming database will be completed with atmospheric electricity (such as potential gradient, lightning, Schumann resonance and VLF – whistler – observations), ionospheric (based on the newly installed ionosonde) and geomagnetic data (hourly and daily mean values of H D Z, derived K index) also. Besides real time access to certain data (such as magnetic recordings), archive data for 50 years, interpretations and tutorial materials will improve the portal.

Keywords: geophysical, observatory, database

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ASV035 **Poster presentation** **3791**

EGY in China: from data center to geophysical informatics

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In this paper, we will give an introduction to the history of the development of WDC for Geophysics, Beijing as well as some work in other data center around this fields, and the initial work in geophysical informatics, including some plans in our country for incoming eGY. The database and website in WDC for Geophysics and Geophysical Data Center for the Geodata Sharing Union in China have been introduced in details. The initial work and plan for China virtual geophysical observatories also have been described.

Keywords: egy, data center, geophysical informatics

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ASV036 **3792 - 3812**

Symposium
Geomagnetic measurements in remote regions (Division V and ICDC)

Convener : Dr. Baldev Arora
Co-Convener : Dr. Angelo De Santis, Dr. Enkelejda Qamili

Lack of measurement and collection of geomagnetic data from many regions of the earth due to environmental, logistic and communication difficulties prevent complete description and, thus, inhibit the search for the physical mechanisms of a number of transient phenomena, e.g., space- time variability of auroral and equatorial electrojets, high altitude and low altitude coupling, influence main field and oceans on transient variations etc. This session focuses on data based and numerically based research suggesting essential configuration of geomagnetic stations, both on land and on ocean floor, to quantify such phenomena, particularly highlighting the strategic gaps in the existing observatory network; for example, Antarctica and the equatorial region. Papers defining strategic locations where measurements of geomagnetic field could improve upon existing geomagnetic indices and models will be of special interest, as well as discussions on the uniqueness of a region and the scientific justification for the placement of the station. Papers describing novel design of equipment, modes of data collection and decimation from the remote regions where there are limited or no power / electronic communication means are particularly welcome.

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ASV036 **Oral Presentation** **3792**

MAGnetic Data Acquisition System (MAGDAS)

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Magdas/cpmn Group

One purpose of the Solar Terrestrial Physics (STP) research in the twenty-first century is to support human activities from an aspect of fundamental study. The scientific new aim for the STP society is a creation of new physics, i.e., multi-scale couplings of the complex and composite Sun-Earth system. The goals for the attainment of the purpose are to construct Network Stations for global observations and Modeling Stations for integrated simulation/ empirical modeling. The Space Environment Research Center (SERC), Kyushu University started to deploy a new ground-based magnetometer network, in cooperation with about 30 organizations in the world during the period of International Heliophysical Year (IHY). The SERC will install the MAGDAS (MAGnetic Data Acqusition System) units at 50 stations in the CPMN (Circum-pan Pacific Magnetometer Network) region, and the FM-CW radars along the 210magnetic meridian. Nearly 20 and 10 MAGDAS units were installed along the 210 magnetic meridian in 2005, and along the magnetic dip equator in 2006. In the year 2007, 20 MAGDAS units will be deployed in places such as South Africa, India, Italy, Mexico, Alaska, Siberia, and Antarctica. The goal of MAGDAS is to become the most comprehensive ground-based monitoring system of the earth's magnetic field. It does not compete with space-based observation. Rather, this ground-based network complements observation from space. To properly study solar-terrestrial events, data from both are required. MAGDAS/CPMN are roughly divided into two portions: (1) magnetometer and data logging/transferring system installed at the CPMN stations: MAGDAS-A system, (2) data acquisition and monitoring system installed in SERC: MAGDAS-B system. The new magnetometer system consists of 3-axial ring-core sensors, tiltmeters and thermometer in sensor unit, fluxgate-type magnetometer, data logging/transferring unit, and power unit. The total weight of the MAGDAS magnetometer system is less than 15 kg. The data transferring unit transfer the obtained data in real time from the overseas stations to the SERC, Japan, by using three possible ways: Internet, Telephone line or Satellite phone line. In order to understand the complex Sun-Earth system and its effects to human lives, we have to clarify global dynamics of geospace plasma environment during magnetic storms and auroral substorms, the electromagnetic response of iono-magnetosphere to various solar wind changes, and the penetration and propagation mechanisms of DP2-ULF range disturbances from the solar wind region into the equatorial ionosphere. The ordinary data from the MAGDAS/CPMN stations can be used for studies of long-term variations, e.g. magnetic storm, auroral substorms, Sq, etc., while the differential- and bandpass-filtered data will be useful for studies of ULF waves, transient and impulsive phenomena. By analyzing these new MAGDAS data, we can perform a real-time monitoring and modeling of (1) the global 3-dimensional current system and (2) the ambient plasma mass density for understanding the electromagnetic and plasma environment changes in the geospace during helio-magnetospheric storms.

Keywords: ihy, magdas, magnetometer network

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ASV036 **Oral Presentation** **3793**

Advanced data logger and communication system for data collection from remote regions

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The question on collection of reliable data from the remote regions like Arctic and Antarctic is still open. The microcontroller data logger for geomagnetic measurement has been developed to solve the problem. The logger is not sensitive to outside temperature; it has very stable analog-to-digital conversion characteristics, preset of sampling rate being up to some tenth of Hz. The timing of data samples is one of the most important issues of the logger. It includes the internal GPS receiver, which ensures the precise synchronization of the sampling process and determination of the coordinate position on the earth. The logger can provide the synchronous measurement at distant points. To ensure the data surviving the flash memory card is used for reliable data storage. The problem of limited power has been resolved by constant supplying the system from the recharging battery and small wind power generator (or solar panel). The on-line transmission of data was provided with proper communication system, which consists of the controller module and radio packet modem transferring the data by VHF radio. The system could be simply expanded by satellite communication modem as well. The logger and communication system have been deployed on polar station Amderma, which is one of the station providing data for AE-index calculation. The system was also installed on some other Arctic and Antarctic stations and showed good stability and reliability during in course of year operation. This logger and communication equipment can be applied for many geophysical monitoring applications and field experiments.

Keywords: logger, data, remote

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ASV036 **Oral Presentation** **3794**

An example of operation for a partly manned antarctic observatory and the development of a radio link for data transmission

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This paper describes the experience acquired from more than ten years of operation of an Antarctic geomagnetic observatory, along with the developed data transmission facilities. The plans for its upgrade in the immediate future are also given. The observatory was deployed at the Spanish Antarctic Station, Juan Carlos I (Livingston Island, South Shetland Islands, 62 40' S, 60 24' W) during the 1996-1997 Austral summer survey. Its three-letter IAGA code is LIV. The main instrument is an Overhauser magnetometer deployed in dual axis Helmholtz coils, a dD/dI configuration. The site is only manned during the summer, but the magnetometer is left recording throughout the rest of the year. Due to the low power requirements of this instrument continuous operation is maintained using a combination of solar cells and wind generators which charge a battery rack. Also during next summer survey the observatory instrumentation will be upgraded with a DMI suspended triaxial magnetometer. All sampling, timing and data transmission will be carried out under the control of a PIC based microcontroller and GPS receiver. Data presentation, transmission and archiving will be performed under the control of a low consumption embedded PC. For real time access to the data two options have been provided and rigorously tested during the last 10 years: METEOSAT and GOES Data Collection Systems, and recently, a high frequency (HF) digital radio-link using ionospheric propagation between Antarctica and Spain has been added. This latest transmission system is being continuously upgraded, and it would be possible to extend its application to other remote stations. Channel measurements have been performed during the last four years in order to determine the channel characteristics and its variability, mainly the multipath and Doppler spread and the link availability for a given SNR in the receiver. These measurements are being used to design the physical layer of a radiomodem intended to maximize the link capacity keeping the emitted power low.

Keywords: observatories, antarctica, hf

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ASV036 **Oral Presentation** **3795**

The british antarctic surveys low power magnetometer project

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Mervyn Freeman

The British Antarctic Survey Low Power Magnetometer Project (LPM) had as its aim the continued year round operation of a network of 11 magnetometers on the Antarctic Plateau between Halley and South Pole (-60 to -80 deg geomagnetic latitude). The magnetometers were to be capable of 1nT and 1s sampling. Each system is powered by a solar panel and rechargeable batteries and must therefore have minimal power requirements during the long dark period of the polar winter. We will describe how knowledge of the signal spectrum is essential for achieving low power and demonstrate the accuracy of the measurements relative to a fluxgate magnetometer of more conventional design. The history and current status of the network will be described, along with a description of how to access the data. The function and sequence of data processing will be described along with steps that have been taken to verify the data and assure its quality.

Keywords: magnetometer, antarctica, instrumentation

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ASV036 **Oral Presentation** **3796**

Need for new geomagnetic observatories in the Indian Ocean

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The geomagnetic variations recorded at couple of French islands (Crozet, Kerguelen) in the Indian Ocean reveal that the regular solar quiet day (Sq) variations in this longitudinal sector of the southern hemisphere do not show the expected V type or inverted V shaped variations in the horizontal component but instead are marked by dominant easterly maxima and westerly minima in the afternoon. Examination of Sq variation in three components for a chain of mid-latitude stations encompassing longitudinal band of 20 to 210 E reveal that the anomalous Sq variations, described above, are the characteristic features of the longitudinal belt 30 to 80 E although certain characteristic deformation in overhead Sq current system can be traced outside this belt as the Sq-vortex fixed with Sun moves from Australian to African sector. A detailed examination reveals that this anomalous deformation of Sq vortex, confined to narrow longitudinal sector, is also characterized by anomalous pattern of main vertical field component, a vital component in the generation of Sq current system through the dynamo mechanism. It is shown that the iso-magnetic field lines in vertical component that otherwise follow the circle of latitude tend to align in N-S direction along this sector. Linking the likely mechanism for the anomalous behavior of Sq-Vortex to the main field inequalities, the need for establishing geomagnetic observatories at strategic islands or at Ocean bottom in the Indian Ocean are emphasized to quantify the role of main field in the modulation and deformation of dynamo mechanism responsible for Sq current system.

Keywords: sq variations, dynamo mechanism

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ASV036 **Oral Presentation** **3797**

Autonomous Low-Power Instrument Platform to enable Remote High Latitude Array Deployment

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A major driver in the advancement of geophysical sciences is improvement in the quality and resolution of data for use in scientific analysis, discovery, and for assimilation into or validation of empirical and physical models. The need for more and better measurements together with improvements in technical capabilities are driving the ambition to deploy arrays of autonomous geophysical instrument platforms in remote regions. This is particularly true in the polar regions where measurements are presently sparse due to the remoteness, lack of infrastructure and harshness of the environment. The need for the acquisition of continuous long term data from remote polar location exists across geophysical disciplines and is a generic infrastructure problem. The infrastructure, however, to support autonomous instrument platforms in polar environments is still in the incipient stages of development. We report the development of an autonomous low-power magnetic data collection system. The prototype is presently being tested at South Pole with the goal of establishing a magnetometer array on the Antarctic Plateau along the 400 magnetic meridian. The system is designed to operate at least 3 years unattended and to provide data access via Iridium satellite communication. The system will store 1-second measurements of the magnetic field variation (0.1nT resolution) in 3 vector components plus a variety of engineering status and environment parameters. The design and test results will be discussed along with future design research plans.

Keywords: polar, magnetometer, antarctic

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ASV036 **Oral Presentation** **3798**

GEOSTAR deep seafloor missions: Magnetic data analysis and main geoelectric characteristics underneath the southern Tyrrhenian Sea

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De Santis Angelo, Di Mauro Domenico

GEOSTAR Project represents an important European program with the main purpose of the deep-sea geophysical investigation by means of an automatic multiparametric seafloor station. In this presentation, we will illustrate the main aspects of GEOSTAR 2 and ORION-GEOSTAR 3 deep-sea missions performed, between 2000 and 2005, in the abyssal plains located at South-West of Ustica Island and North-West of the Marsili seamount (Tyrrhenian sea, Italy), respectively. We will then describe the used instrumentation, the data acquisition, their calibration and orientation. The data analysis consisted mainly in the application of GDS (Geomagnetic Deep Sounding) and MVGS (Magnetovariational Vertical Gradient Sounding) techniques in order to get some information about the main geoelectric characteristics of the investigated area. Finally, on the base of the obtained results, we will propose an electrical conductivity model together with an estimation of the electromagnetic lithospheric depth under the two measurement sites.

Keywords: geostar, deep seafloor, electrical conductivity

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ASV036 **Oral Presentation** **3799**

Two years of continuous record of the Earth's magnetic field at Concordia station (DomeC, Antarctica)

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A new magnetic observatory was opened at the beginning of 2005 in the inland of Antarctica (lat. 7506'S, long. 12323'E) and operated in the more or less standard way, with absolute measurements controlling the triaxial variometer base lines and total field records proving additional redundancy. Since the opening, the field is recorded almost continuously at a one second and one minute rate. The standard absolute measurements are made at a variable rate all over the year. Thus absolute values of the field components are available at any rate lower than or equal to one second. Their estimated accuracy is discussed taking into account the difficulties arising in the operation of an observatory in such extreme conditions as for instance an external temperature varying between minus 30C and minus 70C and a total darkness lasting two months. The validity of the results is discussed in the light of the data provided by the nearest observatories (Dumont d'Urville, Scott Base, Mario Zuchelli base) and in comparison with various global or regional models.

Keywords: magnetic, observatory, antarctica

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ASV036 **Oral Presentation** **3800**

Secular variation and Sq variation in the South Atlantic Magnetic Anomaly

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We report on geomagnetic measurements from a repeat station that is located on the island of Tristan da Cunha within the South Atlantic Magnetic Anomaly and discuss the benefits gained from setting up a magnetometer station on this island. Previously, repeat station measurements on the island have been made by British and South African institutions in 1958, 1960, 1986 and 2002. Several repeat station measurements were conducted by us in 2004 during two days with magnetically rather quiet conditions. This data is compared to global secular variation models and Sq models. The latter are used in lieu of on-site variometer data to estimate quiet night time values for the 2004 data set. There are currently only a few geomagnetic observatories in the region of the South Atlantic Magnetic Anomaly and Tristan da Cunha is located close to the centre of the anomaly. The island is of volcanic origin and therefore strong crustal anomalies and high magnetic field gradients have to be taken into account.

Keywords: south atlantic, secular variation, magnetometer

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ASV036 **Oral Presentation** **3801**

Geomagnetic storms recorded by global network of broadband seismometers

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In the past decade, slow slip events of various spatial size from tens to hundreds of kilometers were detected at various time scales of days, months and years. However, no SSE have not been detected at time scales from tens of minutes to hours. In order to detect the slow slip events at the time scales, we look over broadband seismograms filtered in a period band from 100 s to 3000 s to find synchronous anomalous signals in August 13, 2000, and October 29, 2003, features of which are as below.(1) simple waveform of a few cycles of harmonic oscillations of a predominant period of around 500 s. (2) waveforms are quite similar to each other. (3) arrival time differences are within 10 minutes on the Earth. Although their source should be in the core to meet (3), we can not identified spectral peaks of core modes such as 2S2 (1060 s), 3S3 (700s), 5S1 (580 s), 3S4 (540 s), 3S5 (445 s), 6S2 (410 s), 4S6 (377 s) and 4S7 (330 s) in the FFT spectra, leading to a conclusion that the source of the synchronous anomalous signals is not the Earth's core. We compare continuous geomagnetic records at ALERT, Canada, and KAK (Kakioka, Japan) filtered in a period band of 100 s to 1000 s to find that they remarkable resemble broadband seismic records filtered in the same period band. Comparing the continuous geomagnetic records filtered in a period band of 100 s to 5000 s with the seismic records decomvolved with seismometer response, we find they resemble each other, leading to a conclusion that the anomalous synchronous seismic signal were due to the magnetic storms. We presume that this is the first report that the magnetic storms simultaneously affected geophysical observation on the Earth.

Keywords: geomagnetic storms, broadband seismometers

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ASV036 **Oral Presentation** **3802**

Localizing the North magnetic pole from ground survey and satellite data

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The North magnetic pole (NMP) is the place on Earth where the geomagnetic field is exactly vertical. Since its first localization by a magnetic survey in 1831, the NMP has been located in the Canadian high Arctic and has been slowly drifting toward the North geographic pole due to geomagnetic secular variation. However, the drift speed has been strongly increasing for the last two decades and the NMP is now quickly heading in the North-West direction toward Siberia . If the drift velocity remains constant, the NMP could leave the American hemisphere in less than 10 years, which could have profound implications for space weather. In an attempt to determine the current NMP position, a France-Canada expedition will perform a magnetic survey on the polar sea ice in April 2007. The NMP is almost beyond the range of a Twin Otter aircraft, so that this could well be the last opportunity for direct observation of its position. We will report the results of this survey and compare them to magnetic data provided by the low-Earth orbiting CHAMP satellite. We will also discuss the origin of this move from the point of view of core dynamics.

Keywords: magnetic pole, geomagnetic secular variation, magnetic survey

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ASV036 **Oral Presentation** **3803**

Magneto-seismic Chain in the Arctic Far East (MsCAFE): A Strategic Plan for Improving Ground Observations of Magnetospheric Dynamics

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Using the ground observations of field line resonance to estimate the plasma density in the magnetosphere has been a popular research subject since the 1990s, and the new science to be generated by this practice was one of the major motivations behind the establishment of several new magnetometer arrays in the last decade. Although many stations can provide the field line resonance observations of interest, they are mostly clustered in the North and South Americas and Europe. Here we propose a strategic plan that can effectively expand the coverage of field line resonance monitoring and bring in critical observations for space weather research. This plan calls for a new magnetoseismic chain MsCAFE to be located roughly along the 190th magnetic meridian in Siberia. MsCAFE will complement the MAGDAS/CPMN stations in the region and the SMALL/Meridian Project in . The new chain extends the magnetospheric sounding capability to the Far East, which local time is roughly 8 hours behind the McMAC chain in North America and 8 hours ahead of the European chain. When MsCAFE is established, it can join the observations provided by the other two major magnetospheric-sounding chains in the world and enable non-stop monitoring of the dayside magnetospheric density. The joint operation is also valuable in resolving the spatiotemporal ambiguities in plasmaspheric dynamics since local time plays an important role in the processes taking place in the ionosphere. This strategic plan enhances many types of observational capability, ranging from the studies in magnetosphere-ionosphere coupling, radiation belt forecasting, to the joint observations with other ground-based ionospheric experiment and space-based magnetospheric missions.

Keywords: magnetometer, siberia, space weather

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ASV036 **Poster presentation** **3804**

Geophysical complex of ISTP SB RAS for monitoring of electromagnetic fieds at high and middle latitudes

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The Institute of Solar-Terrestrial Physics RAS SB (Russia, Irkutsk) has got a hardware-software complex for monitoring of electromagnetic fields at high and middle latitudes. This complex includes the following observation stations: 1. Magnetic Observatory Irkutsk, founded in 1886, is dedicated to experimental investigation into the Earths magnetic field by continuous three-component registration of both absolute values and variations of the geomagnetic field in the frequency range between 0 and 5 Hz. The observatory is equipped with the following magnetometric instruments: the flux-gate declinometer-inclinometer for measurement of declination and inclination, the proton magnetometer for measurement of the total vector, and the three-component flux-gate magnetometer for registration of H, D, and Z component variations. 2. Norilsk Complex Magneto-Ionospheric Station is situated on the north of Krasnoyarsk Region, and it has worked since 1962. At this station, there is a vast complex of geophysical instruments for absolute and variational observations of the Earths magnetic field. This complex includes a declinometer-inclinometer, a three-component flux-gate magnetometer, and a proton magnetometer. Registration of geomagnetic pulsations is carried out using the induction nanoteslameter with 10 Hz sampling frequency of three channel scanning. Moreover, at this station there is a digital ionosonde, an oblique sounding station, an LFM sonde, a riometric station, and a cosmic ray station. 3. Baikal Magneto-Telluric Observatory Uzur located on island Olkhon (lake Baikal, 350 km from Irkutsk) has worked since 1962. Continuous twenty-four-hour all-the-year-round observations of low-frequency horizontal electric fields (telluric current, 0.00110.0 Hz frequency range) and three-component measurements of magnetic components of geomagnetic pulsations (induction nanoteslameter, 0.00110.0 Hz frequency range), are performed at this station. Furthermore, measurements of vertical component of electric field of geomagnetic pulsations are realized under special programs (vertical measuring line is in Baikal waters). In this report, some scientific results, obtained from observational materials at these observatories, are presented. In this part, the reconstructed secular variation is described of H, D, Z components of the Earths magnetic field according to the data of the oldest Siberian Magnetic Observatory Irkutsk. The results are shown of the unique experiment on registration of six components (three electric and three magnetic ones) of the Earths electromagnetic field (Baikal Magneto-Telluric Observatory Uzur). Besides, some extraordinary scientific results of synchronous registration of geomagnetic pulsations and variations of ionosphere parameters in auroral latitudes are stated here (Norilsk station).

Keywords: the earths magnetic field, observatory, hardware software complex

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ASV036 **Poster presentation** **3805**

Geomagnetic pulsations of long periods (1,0 10 milihertz) with variation of solar cycle of in the region of the South Atlantic magnetic anomaly Sama

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The characteristics of the geomagnetic pulsations of long periods (100 to 1000 seconds) and its relationship with high energy charged particles precipitation in the SAMA region are studied for some phases of the solar cycle. The Earth magnetic field is anti-symmetrical and the SAMA is an area where this field has its smallest intensity. This anomaly is situated southern to the equator, enclosing part of the Atlantic Ocean and the south of Brazil, northeast of Argentina, Uruguay, and Paraguay. In this region occurs a larger penetration of cosmic rays and particle precipitation of the solar wind causing disturbances in the ionosphere and in the local geomagnetic field. The intensity of the geomagnetic field varies in time scales with short and long periods, from seconds to millions of years. The variations of short scale has been detected by fluxgate type magnetometers installed in the Geomagnetic Station of the Southern Space Observatory of the Southern Regional Space Research Center OES/CRSPE/INPE-MCT, So Martinho da Serra SMS (29,43 S, 53,82 W), Rio Grande do Sul. The SMS pulsation data has been analyzed and compared with data observed in moved away stations out of the anomaly region such as the Geomagnetic Station of Vassouras VSS (22.40S, 43.65W), Rio de Janeiro, from the National Observatory ON/MCT, and the Geomagnetic Station of Eusbio EUS (3,89S; 38,44O), Cear. The results were obtained with the observed H component variation data during the geomagnetic storm occurred in July 22 to 28, 2004. Using a band-pass digital filter to analyze only the pulsations in a range of 180 the 900 seconds it was possible to detect peaks of variation of the long period Pc5 and Pc6 pulsations. Differences in the variation of the H component were observed when comparing the results of the stations at So Martinho da Serra, located near to the center of SAMA, with the Geomagnetic Station at Vassouras, located in the edge of anomaly, and with Geomagnetic Station of Eusebio, located outside of the South Atlantic Magnetic Anomaly. These observed results suggest the need of a continuous monitoring of these phenomena at the SAMA Region.

Keywords: geomagnetic pulsations, magnetometers, sama

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ASV036 **Poster presentation** **3806**

Low and mid-frequency pulsations in the polar cap: polarization pattern and MLT dependence of the spectral power during the descending phase of the solar cycle

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The results of a statistical analysis of the polarization pattern and the magnetic local time dependence of the spectral power of low and mid-frequency (1-100 mHz) pulsations in the polar cap are presented. The analysis has been performed using data from the Antarctic stations Mario Zucchelli (Terra Nova Bay, CGM lat 80S) and Concordia (Dome C, CGM lat. 89S) during 2003-2006. The results are interpreted in terms of the different latitude of the two stations which may be linked to different magnetospheric regions: Dome C in the deep polar cap and Terra Nova Bay approaching the cusp around noon. In these regions different mechanisms for wave generation and propagation can be active. We also discuss the aspects of seasonal and interplanetary conditions dependence of the polarization pattern.

Keywords: polar cap, ulf waves, geomagnetic measurements

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ASV036 **Poster presentation** **3807**

An experience of tectonomagnetic investigations in Western Antarctic

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The specific mode of access to the Antarctic Peninsula, its complicated geographical and climatic conditions make difficulties for geological and geophysical investigations. In this connection the deep structure and recent geodynamics of the Earths crust are insufficiently studied here. To investigate magnetic field variations, caused by geodynamic processes in the lithosphere nearby location of the Ukrainian Antarctic Station (UAS) Academik Vernadsky (former British Faraday, 6515S and 6416W) in 1998 were started works for creation of a tectonomagnetic polygon and tectonomagnetic monitoring. A tectonomagnetic method, as proves a world-wide experience, gives good enough results during mapping of active tectonic faults, investigations of seismic-tectonic processes and earthquakes precursors, tectonic zoning and other geological-geophysical tasks of geodynamic orientation salvations. The all this problems are also actual for the Antarctic Peninsula. Long-term points of tectonomagnetic observations were founded mainly on islands of the Argentine Archipelago (from Pitterman island on the North, to Barcelot island on the South, from Barchany island on the West to Rasmussen Cape on the East) along two tectonomagnetic profiles: sub-latitudinal No.1 (Barchany Rasmussen) 11 km long and No.2 (Barcelot Pitterman) 30 km long. During 1998 2005 years were founded 15 tectonomagnetic points and fulfilled 6 cycles of geomagnetic observations. It was determined, that in this region exist magnetic anomalies in the range of 500 1000 nT, caused by highly magnetized intrusions. New data about dynamics of the local magnetic field on the West coast of the Antarctic peninsula were obtained during long-term geomagnetic observations in the location of the Ukrainian Antarctic Station Academik Vernadsky. A spatial-temporal structure of geomagnetic field variations conforms to elements of a tectonic structure. The most intensive tectonomagnetic anomalies were defined on the Three Pigs island. During 1998 2005 years they reached - 18.5 nT (- 2.6 nT/year). Such amplitude of tectonomagnetic effects is connected with a high magnetization of rocks and intensive tectonic tensions in the regions crust. The interpretation of defined anomalies was done in the context of piezo-magnetic mechanism. And on the base of mathematical modeling data was stated, that crust blocks in the Argentine Islands are being exposed by horizontal stretching forces in sub-latitudinal direction. Works were made under the support of the National Antarctic Scientific Centre of Ukraine.

Keywords: tectono magnetic, antarctic, geodynamics

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ASV036 **Poster presentation** **3808**

Estimations of magnetic coseismics polarization parameters for Koyna earthquakes

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The development of earthquake (EQ) electromagnetic (EM) source models is very actual problem for each seismo-hazardous region because it can take into account the local specific geological structure and geophysical peculiarities. Very important part of this problem is an experimental study of coseismic effects. Coseismic EM signals studies have fixed mainly on seismo-electric signals, because of very simple instrumentation and big magnetic field interference at magnetic field measurements. However the measurement of three-component coseismic magnetic field in ULF band (0.03-10 Hz) is appropriate for study of EM source at seismogenic depths. For this purpose we analysed data from the induction type three-component magnetometers LEMI-30 which were located in stationary measurement site near Kolhapur and temporary site near Koyna (both are in Maharashtra, India). These sites have quiet enough background EM noise and placed in seismo-active area. The data during two clustered EQs which occurred in 2006 on April, 17 at 16.39.58.87 (M=4.7, h=10 km, 17.07 N, 73.69 E) and May, 21 at 20.29.00.29 (M=3.7, h=10 km, 16.9 N, 73.61 E) have been analyzed with emphasis on coseismic events. The distance from both magnetometers to EQ epicentres did not exceed 50 km. The clear magnetic coseismic signals were observed in all components of both magnetometers. The wave form, dynamical, wavelet spectra and polarization ellipse parameters of these signals have been studied and compared with seismic and natural magnetic field data. A full analysis of these data from both measuring sites will be presented in our poster. This work is partially supported by STCU grant 3165.

Keywords: earthquake, magnetic, coseismics

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ASV036 **Poster presentation** **3809**

Measuring the magnetic field in remote regions using low-altitude airship platform

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As a result of extreme climatic conditions, measuring the magnetic field near the Earths poles has always been challenging. The primary goal of the Total Pole Airship mission, investigated by the Septime continent association, is to measure the ice thickness of the sea ice from an airship platform. In addition to other remote sensor devices, the airship (a dirigible balloon) will carry a scalar magnetometer in order to simultaneously measure the magnetic field. The outcomes of this mission are of scientific and technical interest, and this paper discusses its feasibility and scientific perspectives from the magnetic field point of view.The dirigible balloon will cross the Arctic region between April and May 2008, and it will record the magnetic field along profiles at 50m altitude. These new data could help to re-level existing magnetic compilations over the Arctic region. During the mission, the airship will move towards the north magnetic pole, almost a year after the French-Canadian expedition to the North Pole (April 2007). The absolute scalar magnetometer (ASM) is scheduled to be provided by the CEA-leti and will be similar to the device likely developed for the Swarm satellite mission (scheduled for 2010).

Keywords: anomaly field

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ASV036 **Poster presentation** **3810**

Experimental studies with a fluxgate magnetometer of toroidal core

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The fluxgate magnetometers are instruments used for measuring geomagnetic field and its variations. The objective of this work is to construct a ring core magnetometer based on fluxgate principle. The magnetometer described here is constituted by three orthogonal sensors (H, D, and Z components) with a toroidal nucleus. Each sensor is composed for two bobbins in each axis, one for excitement and another bobbin for the second harmonic signal detection which is proportional to the surrounding magnetic field. The functioning of this sensor is based on properties of high permeability material of the ring core. The electronic circuit used in the construction of the magnetometer has three stages. The first stage consists of the generation of a periodic signal of frequency f capable to saturate the iron magnetic nucleus twice per cycle of the excitation signal. The second stage of the circuit is for the detection of a DC signal proportional to the geomagnetic field variation by comparing the phase of the signal obtained from the sensor coil with the original 2f signal from which excitation signal f was obtained. After the comparison of the signals is made follows the stage of an integrator which provides smoothed variations proportional to the surrounding geomagnetic field. This type of a magnetometer is a versatile equipment for the detection of geomagnetic field ranging from 0,1nT to 1mT.

Keywords: toroidal, fluxgate, geomagnetism

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ASV036 **Poster presentation** **3811**

Prospects of the Far-Eastern observatories in the framework of International Programs of Geophysical Polar Year

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In 60-es after the International Geophysical Year (IGY) a big program on development of magneto-ionospheric station network, spreading all over the Far East, was realized. Geomagnetic observatory data obtained during the last half century after the IGY have enlarged our knowledge on magnetic disturbances and their connection with phenomena in near-ground space. IKIR includes 5 observatories which have continuous observations of geomagnetic field: Zabailalskoe, Khabarovskiy krai (1968), Stekolniy, Magadanskaya oblast (1932), Kluchi, Sakhalinskaya oblast (1932), Cape Shmidta, Chukotskiy krai (1967), Paratunka, Kamchatskaya oblast (1968).Modern stage of development of geomagnetic measurements is characterized by extensive introduction of information technologies, digital techniques of data registration and storage, reduction of time for data access in real-time mode. All these bring the observatory on a new qualitative level opening new areas of application of geomagnetic data.Paratunka observatory (PET) is the basic one in the Far East. In the framework of joint investigations with the Commmunication Research Laboratory (CRL) of the Ministry of Posts in , supported by Prof. Dr. Takashi Kikuchi, a flux-gate magnetometer FRG-601 was installed at the observatory within the framework of the International project Detection and Selection of Electromagnetic Precursors of Earthquakes in Earth-East Pacific Region and Study of its Physical Mechanism. Thanks to Prof. J. Rasson, in 2003 a DI-magnetometer Lemi-203 (Ukraine, 2004) was given to Paratunka observatory which already carries out magnetic measurements according to Intermagnet requirements sending minute data to GIN Edinburg in test mode. In 2004 a new flux-gate magnetometer MAGDAS (Space Environment Research Center Kyushu University) was set for measurements with the help of Prof. Dr. Kiyofumi Yumoto according to the program of international Climate and Weather of Sun-Earth System. Since 2007 international cooperation with GeoForschungsZentrum Potsdam (GFZ) is planned, it is supported by Prof. M. Mandea. GFZ intends to help the Institute of Cosmophysical Research and Radio Wave Propagation by installing modern digital geomagnetic instrumentation at Stekolniy observatory. This will modify and replace outdated equipment and IKIR observatory will become a valuable participant of international data network.There is hope that, similar to the way, how the first IGY became the catalyst for developing and realization of the program on building the network of magneto-ionospheric stations, the IGY-2007 will bring new decisions to solve the problems in the work of all the five magnetic observatories of IKIR and new prospective.

Keywords: far, east, observatory

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ASV036 **Poster presentation** **3812**

Development of a small autonomous unmanned helicopter for aeromagnetic survey

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It is difficult to detect the magnetic anomaly resulting from mall scale of magnetic sources asarcheological or historical ruins by manned helicopter due to requesting low altitude flights. Although a relatively small unmanned helicopters has been commercialized for agriculture useetc., it is too expensive for aeromagnetic surveys. We have developed a small autonomousunmanned helicopter modified based on a model helicopter for not only aeromagnetic survey butalso geophysical research. A helicopter (Hirobo Co.; SF40) of an 40cc gasoline engine, length of 143cm from the head tothe tail and dry weight of 15 kg is selected in this study, SF40 has the total magnetic field(R)=3511 nT, inclination (I)=12 and declination (D)=138 at the bottom-center of skid. Themagnetic field was reduced to about 1 nT under 3 m downward from the skid during thehovering. When SF40 was covered by a magnetic shield film (Amoric sheet), the distance wasdiminished to 2 m. As the shielding of body is not effective for reliable and safety flights, we areshielding the source (servomotor) of the magnetic filed by the film. The helicopter can benavigated by an autonomous flight control system using GPS in present. Magnetometer system consists of 3 axis fluxgate magnetometer, data logger, GPS and battery,recording every second of x, y and z magnetic fields, latitude, longitude, altitude and satellitenumber during 3 hours. The total weight of the system is 400g. The system was hanged to 2 mlower from the skid in order to avoid the magnetic field of SF40. Archeological ruins of iron steel refinement aged the middle century in western Japan wasmeasured on foot at 70 to 200 cm in height from the ground using the magnetometer system. Themaximum peak anomaly was 1100 nT at the 2m above from the surface. The anomaly may bedetected up to 10 m above by the on-board magnetometer system.

Keywords: helicopter, aeromagnetic survey, archeology

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ASV037 **3813 - 3844**

Symposium
International Decade of Geopotential Field Research: Current achievements and expected impact of Swarm (Divisions V, and I, II, III)

Convener : Dr. Eigil Friis-Christensen
Co-Convener : Dr. Vincent Lesur, Dr. Stefan Maus

The Decade of Geopotential Research, inaugurated with the launch of rsted and Sunsat in February of 1999 is now in its 9th year. The combination of high quality data sets from several near-Earth satellites and ground based measurements has opened numerous opportunities to study not only core processes, mantle conductivity, lithospheric composition and ocean flow but also the dynamics of ionospheric and magnetospheric currents. Contributions on all these topics are solicited for this session. In addition, we welcome papers dealing with the difficult separation of the various sources of the field and the implications for the forthcoming multi-satellite SWARM mission.

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ASV037 **Oral Presentation** **3813**

Recent achievements in characterising ionospheric current systems

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Stefan Maus, Claudia Stolle, C. Manoj, Patrick Alken

The recent magnetic field missions have brought about an enormous progress in the understanding of near-Earth external field structures and the description of their sources. The equatorial electrojet, for example, is a prominent current system on the dayside. Based on observations from Oersted, CHAMP and SAC-C a rather comprehensive picture of its temporal-spatial variability could be achieved. It is the first time that details of the seasonal-longitudinal variation could be quantified. At higher altitude the effect of the F-region dynamo could be verified experimentally. This wind-driven generator sets up meridional current systems both around noon and sunset. In recent years more and more evidence has been presented that there are also significant currents flowing on the night side. They are found primarily at F region altitudes where ion-neutral collisions are less important. These currents are driven predominantly by plasma processes. Among others, gravity and pressure gradient forces are acting on the charged particles, but also plasma irregularities like plasma bubbles cause detectable currents. Traditionally, the ionospheric influence on main field modelling was assumed to be negligible during night time. The mentioned F region currents are shown, however, to cause magnetic fields of order 5 nT. Techniques have been developed for first order corrections and for data selection. A more appropriate method would be to consider all the current drivers in a self-consistent ionospheric model and use this model to derive magnetic field corrections. The constellation mission Swarm is expected to provide the necessary observational input for such an approach.

Keywords: ionosphere, currents, field model

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ASV037 **Oral Presentation** **3814**

Core Flow Modelling using CHAMP satellite vector data

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Modelling of the flow at the top of the outer core generating the observed secular variation (SV) on the surface of the Earth is open to considerable ambiguity. Several methods adopting different physical assumptions do, however, lead to similar flow velocity maps, despite the varied sources of input data. We initially use a method for directly inverting the observed secular variation from fixed ground observatories, rather than through the use of spherical harmonic models, in order to produce a better prediction of the time evolution of the field over the short term (i.e. 5-10 years). We have tested iterative one-norm minimisation models and find that they better describe the secular variation than the current two-norm models using the steady flow assumption. We investigate the use of different 'best-fit' or 'minimisation' methods in core flow modelling based on past records of SV. We show, as examples, flows generated using the dataset modelled by Wardinski and Holme (2006), in conjunction with the GUFM main field model. We then further extend the study to include the calculated secular variation at an evenly-distributed global vector dataset of 'virtual observatories', (Mandea and Olsen, 2006) fixed at a height of 400km above the Earth's surface, derived from the CHAMP satellite data from 2002 to 2006. We invert this dataset and examine the modelled core flows, comparing them to those calculated from the sparse, unevenly distributed ground observatory dataset. We aim to use the core flow models to predict future SV more precisely than previous methods (such as non-linear extrapolation). Incorporating secular variation calculated from newly available satellite datasets into the modelling of core flows may lead to better understanding of flow processes at the core-mantle boundary.

Keywords: core flows

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ASV037 **Oral Presentation** **3815**

The ionospheric magnetic field over Europe during the 20 November 2003 geomagnetic storm

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Existing geomagnetic models describe the internal and external magnetic fields on quiet days. They are not designed to be used during geomagnetic storms. However, there is a need to accurately describe external field variations at all latitudes during a storm, in order to better understand storm-time processes in the ionosphere and magnetosphere. In this preliminary study, we investigated geomagnetic variations recorded in European magnetic observatories during the 20 November 2003 geomagnetic storm, which was one of the biggest storms in recent decades. We removed the internal part of the observed magnetic fields using the POMME3 model, which describes the core and crustal fields by a spherical harmonic expansion up to degree 90. We also used POMME3 to remove the magnetospheric field, assuming that changes in the geometry of the quiet-time ring current and tail current during the storm do not contribute to the ground magnetic field. We then analyzed the spatiotemporal distribution of the remaining contribution and compared it with the ionization of the ionospheric E-layer obtained from several European ionosonde data. The results suggest that most of this contribution is of ionospheric origin and can be interpreted in terms of electrical currents in the auroral ionosphere, which is found to expand equatorwards down to latitudes as low as 55N. The deduced current geometry is in good agreement with equivalent currents modelled from the Greenland magnetometer chain (operated by DMI) during the same storm. Based upon these results, ways to model thestorm-time ionospheric magnetic field will be discussed in the context of the upcoming Swarm mission.

Keywords: geomagnetic storm, ionospheric currents, geomagnetic model

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ASV037 **Oral Presentation** **3816**

Effects of the neutral atmosphere on the Earths magnetic field after a storm.

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The neutral wind dynamo driven currents in the E-region of the ionosphere are one of many sources contributing to the Earths overall magnetic field. Characterisation of the various sources is a vital step in understanding the Earths whole magnetic environment from the core to the magnetosphere. We have used the Coupled Thermosphere Ionosphere Plasmasphere model (CTIP) to assess the impact of neutral particle inertia after a geomagnetic storm on the magnetic field. We have conducted one model run which starts with a period of 12 hours of intense geomagnetic activity and one completely quiet run as a control experiment. The resulting three dimensional current structure has been converted to a magnetic field at the Earths surface using a Biot-Savart integration. Our results indicate a small (a few nanoTesla), but long-lived (of the order of a few days) elevation in the radial magnetic field originating from the neutral wind dynamo currents.

Keywords: geomagnetism, thermosphere, ionosphere

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ASV037 **Oral Presentation** **3817**

Global EM induction by time-varying external magnetic fields

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There has been an increasing interest in global electromagnetic (EM) induction studies during the last years, mainly because of two reasons. Firstly, due to the tremendous increase of global geomagnetic satellite measurements that have become available. Indeed, 20 years after the Magsat satellite mission, the satellites Oersted, CHAMP, and SAC-C measure the magnetic field and its variation from low altitudes (400-800 km) with unprecedented accuracy. Moreover, the ESAs three-satellite geomagnetic constellation mission Swarm is scheduled for launch in 2010. In contrast to land-based data from geomagnetic observatories, which are sparse and irregularly distributed, satellite-borne measurements provide an excellent spatio-temporal coverage with high-precision data of uniform quality. This gives an intriguing chance to tackle the most challenging problem of deep EM studies: detection of three-dimensional (3-D) variations of electrical conductivity in the Earth's mantle. The second reason for the renewed interest in global EM induction studies is also due to investigations of satellite geomagnetic data. A main objective of geomagnetic satellite missions is the study of core dynamics, geodynamo processes, core-mantle interaction, as well as mapping of the lithospheric magnetization and its geologic interpretation. For these studies it is essential that the derived magnetic field models are contaminated as little as possible by fields originating from the ionosphere and magnetosphere and their Earth-induced counterparts. Until now the conducting Earth is either neglected or assumed to be spherically symmetric (1-D) when deriving model of the core and crustal field. As a consequence, the EM effects due to induction in the oceans have been ignored. During the talk we will present recent results of model studies that aim at predicting magnetic signals (at ground and satellite altitude) induced by a variety of realistic sources in a 3-D conductivity model of the Earth which includes oceans of laterally variable conductance and a 1-D conductor underneath. In particular, we consider 3-D induction due to geomagnetic storms, Sq, and equatorial and polar electrojets. We show that the ocean effect contributes significantly to the near-Earth magnetic field, and demonstrate that an anomalous behaviour of the magnetic field variations at many sites around the globe is caused by 3-D induction in the oceans. Finally, we present a global 1-D conductivity model obtained by analysis of five years (2001-2005) of simultaneous magnetic data from the three satellites Oersted, CHAMP and SAC-C. We demonstrate that correcting the data for the ocean effect yields a conductivity model which is rather similar to those derived from ground-based data.

Keywords: induction, oceans, modelling

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ASV037 **Oral Presentation** **3818**

On Recent Geomagnetic Jerks

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Evidence for the occurrence of a geomagnetic jerk around 2003 has been found in magnetic ground and satellite data, and is also supported by observations of the length-of-day variation. We report on the jerk as seen in an updated version of the CHAOS magnetic field model, in CHAMP satellite derived monthly means at "virtual observatories" in space, and in ground-based magnetic observatory data. We show that the 2003 geomagnetic jerk is not worldwide in occurrence, and present a possible mechanism consistent with the observed correlation between the jerk and the length-of-day variation.

Keywords: geomagnetic field, satellites, geomagnetic jerk

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ASV037 **Oral Presentation** **3819**

Modeling the lithospheric magnetic field combining sequential data filtering and local basis functions

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The forthcoming Swarm mission will provide an unprecedented view of the magnetic crust at high resolution and new modeling techniques, as well as accurate data processing, will become increasingly necessary. The near-Earth magnetic field is a complex superposition of magnetic fields from different sources with overlapping time and space scales and a possible way to disentangle the signal is to use a sequential filtering based on a satellite track-by-track analysis. This along track filtering is often suspected to introduce spurious features in lithospheric magnetic models. In this paper, a regional method is proposed to highlight small-scales signals usually smoothed and filtered out by spherical harmonics. Using four years of sequentially filtered CHAMP satellite data along satellite tracks, a lithospheric model is estimated at 400km altitude over the entire sphere by stitching independent regional models. The model shows new sharp signatures of possible lithospheric origin but the residual analysis suggests a possible contamination from the along track filtering. Thus, the theoretical effects on high-resolution modeling of a sequential data filtering are analytically described in order to highlight and quantify the possible artifacts. Using recent magnetic field models, the strength and the shape of the artificial signal are estimated and the contamination of magnetic field models illustrated. A very simple but effective precaution is introduced to lower the artifacts induced by the track-by-track filtering. It is finally showed that the modeling and processing improvements are fruitful when considering the Swarm mission.

Keywords: rscha, modeling, track by track

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ASV037 **Oral Presentation** **3820**

Satellite Data Selection, Treatment and Modelling in Global Geomagnetic Field Models

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Modern (post 1999) satellite and observatory measurements of the global geomagnetic field have yielded a dense spatial and temporal distribution of vector and scalar geomagnetic data. These data have allowed an unprecedented resolution and analysis of the magnetic signals present in the geomagnetic field vector. By combining improved data selection and modelling methodologies, great improvements have been possible, in particular in the understanding of the smaller signals, for example, those due to ocean induction, or from ionosphere-magnetosphere coupling currents. In this paper we examine the scope for further improvements in satellite data selection and treatment, relevant to the Swarm mission. We concentrate on the main (core plus lithospheric) field, where other sources alias potentially biased and non-Gaussian signals into the internal field. We consider: a) whether local estimates of external field activity can be used to better reject small scale, non-internal, features present in sampled data (as opposed to standard large-scale geomagnetic indices); b) the relationship between satellite and observatory based estimates of field variability at the sample point; c) whether data weighting has a role, particularly where rigorous selection may decimate the evenness of the model data set; and d) the potential for improved modelling of the dayside quiet (and regular) solar variation. We will comment on the relative improvement, or otherwise, in spherical harmonic degree 40 internal field models, using various criteria. We are particularly interested in the higher latitudes, where auroral and polar fields can be large and dynamic. We will also consider what lessons may be learned from this work that will be useful in interpreting data from the future Swarm mission.

Keywords: global geomagnetism, satellite magnetic survey

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ASV037 **Oral Presentation** **3821**

How special is the present geomagnetic field?

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De Santis Angelo

The present period of time is very special for the geomagnetic field: there are some evidences for a peculiar behaviour of the field that is rather different from the rest of last few thousands of years, and that could be due to a possible imminent change of polarity or an excursion of the geomagnetic field. In this presentation we will look at the behaviour of some physical and statistical quantities of the geomagnetic field for the last 7000 years. These results support the case of a possible present occurrence of a such a critical phenomenon for our planet. Next SWARM mission will allow to better assess this interesting aspect of the present geomagnetic field.

Keywords: geomagnetic field, geomagnetic reversal, geomagnetic excursion

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ASV037 **Oral Presentation** **3822**

Improved Lithospheric Field Recovery Using Magnetic Gradient Data: Results of a Swarm Mission Simulation

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The upcoming Swarm constellation mission will offer a unique opportunity to use magnetic field gradients to enhance lithospheric field signals, since the lower satellite pair, flying side-by-side with longitudinal difference of 1.5 degrees (corresponding to 170 km near the equator) allows measurement of the East-West Gradient of the magnetic field, in addition to the field itself.Within a full 4-year Swarm mission simulation we created, for each of the three Swarm satellites, synthetic data containing signal from all major sources (in the core, lithosphere, ionosphere, magnetosphere, mantle and oceans) as well as realistic instrument noise. These synthetic data have then been used to recover the various field contributions, with special emphasize on the high-degree lithospheric field, and on a multi-satellite alignment(transformation from the instrument to the North-East-Center frame) of the vector data.For exploiting field and gradient information in a comprehensive inversion approach we developed a new "selective infinite-variance weighting scheme", which uses gradient information to recover lithospheric coefficients above spherical harmonic order m=20, and the field data itself to recover all other source contributions. Application to the synthetic Swarm data set allows for a recovery of lithospheric signals well above degree 133 (i.e. down to wavelengths of 300 km).

Keywords: swarm, lithospheric field, geomagnetic satellite

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ASV037 **Oral Presentation** **3823**

Magnetic fields due to motional induction in the oceans

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Flow of conductive, saline water of the ocean in the ambient geomagnetic field is known to induce magnetic fields which can reach distant land and satellite observatories with detectable signal amplitudes. The depth integrated flow directly impacts the magnetic and electric field generation associated with water movement. The implications are that (1) the ocean flow generates non-trivial (?) magnetic fields, and these need to be considered while processing geomagnetic data and (2) the measured geomagnetic data contain signatures of ocean flow and these data can possibly be used to infer the flow strength and variability. This paper describes an overview of the recent efforts to study the motional induction due to ocean circulation, tides and tsunami. We apply an integral equation approach to calculate motionally-induced magnetic fields. We assume 3-D conductivity model of the Earth which contains a surface thin shell of variable conductance and realistic 1-D mantle underneath. Different ocean models are used to derive the depth-integrated flow velocities. The magnetic signals due to ocean flows show diverse characteristics on different spatial, temporal and frequency scales. The magnetic signal due to motional induction reaches up to 10 nT at sea level. At typical altitudes of a low-Earth orbit satellite (400 km or so), the effects from various types of ocean flows are within 2 nT. While detection of tidal magnetic fields is now possible from the observatory and satellite magnetic measurements, the extraction of magnetic fields related to ocean circulation from the satellite derived magnetic data is a challenging task. This is primarily due to the fact that the mean (steady) signal is hardly distinguishable from the time-invariant crustal magnetic field. However the variability of magnetic signals induced by the ocean circulation is a promising subject. The increasing sophistication in geomagnetic field models allow for the removal of small amplitude/spatial-scale signals from the measured data and the upcoming three-satellite mission Swarm is expected to yield highly accurate magnetic data. Both these factors will encourage the future research on motional induction in the oceans.

Keywords: geomagnetic, motional, induction

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ASV037 **Oral Presentation** **3824**

Swarm- Mission Status

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Swarm is the fifth Earth Explorer mission in ESAs Living Planet Programme. The objective of the Swarm mission is to provide the best ever survey of the geomagnetic field and its temporal evolution, in order to gain new insights into the Earth system by improving our understanding of the Earths interior and climate. The mission is scheduled for launch in 2010. After release from a single launcher, a side-by-side flying lower pair of satellites at an initial altitude of about 450 km and a single higher satellite at 530 km will form the Swarm constellation. High-precision and high-resolution measurements of the strength, direction and variation of the magnetic field, complemented by precise navigation, accelerometer and electric field measurements, will provide the necessary observations that are required to separate and model various sources of the geomagnetic field. At present the project is close to the end of the design phase B. The current project status, the mission design, satellite concept and performance will get special attention during the presentation.

Keywords: swarm

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ASV037 **Oral Presentation** **3825**

Cleaner geomagnetic jerks to probe core dynamics

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Geomagnetic jerks are a well-known, often-explained, but still rather enigmatic feature of the secular variation. A particularly promising suggestion is that the jerks are a result of torsional processes within the core (Bloxham et al, 2002), in part supported by analysis of decadal variations in length-of-day (Holme and de Viron, 2005). However, while this hypothesis explains some features well (in particular the 1969 jerk in seen in the Y component at European observatories), other locations (particularly southern hemisphere) are less clearly fit. We examine whether this problem is due to issues of data treatment. We seek better estimates of internal secular variation by 1) subtracting modelled external signal using the comprehensive model; 2) using Kp to provide a magnetically quiet-time limit for the calculation of monthly means; 3) examining the three components of the field in a coordinate system defined by the remaining noise on the data, seeking two (rather than the usual one) directions in which the jerk may beclearly seen; 4) particularly careful treatment of data in regions where observatory coverage is sparse. These estimates are then used to perturb a time-dependent model of the main field to seek a model that better represents the fine-scale structure of the jerks. The implications for the dynamics leading to the secular variation are discussed. References: Bloxham, J., Zatman, S., Dumberry, M., 2002. Nature, 420, 65-68; Holme, R., de Viron, O., 2005. Geophys. J. Int., 160, 435-439.

Keywords: geomagnetic jerk, length of day, torsiontal oscillations

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ASV037 **Oral Presentation** **3826**

Towards CM5: Concepts, Approaches and Data Used in Improving the Comprehensive Model

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The "comprehensive" magnetic field suite of models have attempted to providea basic separation of the major field constituents in the near-Earthenvironment for over ten years now. The latest model, CM4, is often used toproduce reference fields for the core, crust, and ionosphere. This model,however, is becoming outdated in that Oersted and CHAMP satellite measurementsare only used through 2002.5, and these don't include CHAMP vector data. Inaddition, the induced field parameterization is rather rudimentary. This talkwill discuss the data processing techniques and the field parameterization andestimation approaches being applied to the next-generation model CM5, whosedevelopment is now underway.

Keywords: comprehensive modelling, oersted champ, induction

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ASV037 **Oral Presentation** **3827**

Spatio-temporal characterization of the equatorial electrojet from CHAMP, Oersted, and SAC-C magnetic measurements

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The equatorial electrojet (EEJ) is an eastward electric current, flowing in a narrow band along the dip equator in the ionospheric E-region. TheEEJ current strength is the product of the dayside eastward electric field and the Cowling conductivity. Both of these are important parameters in the dynamics of the ionosphere.The EEJ has a strong magnetic signature in measurements of low-orbitingsatellites. To characterize the EEJ, we use a combined data set of magnetic readings from CHAMP, Oersted and SAC-C, comprising more than 75,000 equator crossings from 1999 to 2006. First, these satellite passes across the magnetic equator are inverted individually for the peak EEJ sheet current strength. We then describe these peak currents by a statistical model. This empirical model describes the mean and variance of the peak current as a function of longitude, local time, dayof the year, and F10.7. Our climatalogical model has been verifiedagainst vertical drift data from Jicamarca, and has been madeavailable online. The EEJ being an extremely variable currentsystem, we were further interested in its auto-correlation in longitude and time. Previous studies using a single satellite could not separatethe spatial from the temporal variability. However, using the multi-spacecraft constellation, we can infer the auto-correlation of theEEJ as a function of the longitudinal and temporal separation of twoobservers.

Keywords: electrojet, ionospheric

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ASV037 **Oral Presentation** **3828**

Integration of satellite data with historical data in time-dependent field models

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In our new models of the geomagnetic field through time, we attempt to treat as many types of data as possible in an optimal manner. We are, however, faced with the difficulty of integrating satellite data withold survey data, observatory data and repeat station data, when it is clearly the case that the satellite data have vastly more spatial resolving power than the other data sets, which are heterogeneously distributed in both space and time. When one models the field at the core-mantle boundary, the satellite data has the effect of introducing more short-wavelength structure into the model, and if a time-dependent model is being built, the model becomes gradually rougher in time.We will report on some possible strategies for alleviating this effect:one possible strategy is based on the adoption of the so-called frozen-flux hypothesis, namely the infinite conductivity limit for the core. A necessary, but not sufficient condition, for the hypothesis to be obeyed, is that the "unsigned flux" (which counts the number of field lines without reference to their sign) must remain constant in time. This constraint is non-linear and requires some special strategies to deal with it. We will report on progress towards a new generation of time-dependent field models.

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ASV037 **Oral Presentation** **3829**

Modeling of the global distribution of ionospheric electric fields based on realistic maps of field-aligned currents

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A new approach for modeling the global distribution of ionospheric electric potentials utilizing high-precision statistical maps of FACs derived from measurements by the Ørsted and Champ satellites as input to a comprehensive numerical scheme is presented. The boundary conditions provide a correct treatment of the asymmetry of conductivity and sources of electric potential between the northern and southern hemispheres. Since the FAC model is fully parameterized by the IMF conditions, by season, and by hemisphere, the same parameterization is further applied for the convection model. From the conductivity side, both the solar and auroral precipitation contribution is included. Our model allows obtaining the convection patterns developed simultaneously in both hemispheres for given input parameters (the IMF Bz, By, day of the year, UT, Kp, F10.7) complemented by corresponding maps of FAC and conductivity. The model can be used as a tool for improved understanding of global electrodynamics. The convection patterns reproduce all common features inherent in statistical models. In particular, a rather complicated dependence of the convection patterns on solar zenith angle (both seasonal and UT-variation) linked with the IMF clock angle is found. Taking into account the electrodynamic coupling of the opposite hemispheres, our model can handle the electric field far below the auroral latitudes. It allows a simulation of the electric field disturbances that originate at the polar regions but cover a broad range of latitudes in both hemispheres as well as an accurate mapping of ionospheric electric potentials into the magnetosphere. The validation of the model was provided by a comparison with results from existing models as well as with ground and satellite observations of the ionospheric electric field. We discuss how further development of direct measurements of FAC and adjustment of the FAC to conductivity distribution could improve the accuracy of the ionospheric electric field modeling.

Keywords: field aligned, currents, convection

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ASV037 **Oral Presentation** **3830**

High-accuracy crustal field studies from the ST-5 constellation

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The ST-5 satellite constellation collected vector magnetic field observations at altitudes as low as 302 km, with spacecraft separations of 100-500+ km. Although this technology demonstration mission was not designed to do geomagnetism, as it carried no absolute magnetometer, no star camera, and no GPS, I show that the magnetic field gradients of the total field anomaly are of an accuracy comparable to that achieved by missions such as CHAMP, Oersted, and Magsat. This is illustrated using both the entire low-altitude data set, and using a subset of the data taken at the lowest altitudes with comparable satellite-satellite separations.

Keywords: gradiometry, crust, satellite

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ASV037 **Oral Presentation** **3831**

Analysis of ST5 satellite data for micropulsation studies

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The ST5 Mission is part of NASAs New Millennium Program of technology demonstrators. The ST5 constellation consisting of three micro-satellites in a string of pearl configuration, was in sun-synchronized, dawn-dusk polar orbit, from 22 March to 21 June 2006, collecting vector magnetic data from a spin stabilized platform. The orbit perigee and apogee is 300 km and 4500 km respectively. Out of the three spacecrafts, the leading spacecraft SC-155 was around 2910 km ahead of the next spacecraft (SC-094) and the separation between the middle and trailing spacecraft (SC-094 and SC-224) was 397 km, at the start of the Mission. This configuration of multiple satellites provides a unique opportunity for separating the spatial and temporal variations of geomagnetic oscillations. There is much debate on the generation and propagation of Pc3-Pc4 (7 to 100 mHz) pulsations in the equatorial and low latitude regions. In this study, we concentrate on low latitude (geomagnetic latitude from 200N to 200S) magnetic pulsations in the longitude range around the Japanese sector. We select days for which the CHAMP satellite data are also available in the same UT sector and use the data sampled at 1 second interval form Kanoya / Kakioka Observatories for ground constraints.Data for 29 March, 2006 from all three ST5 satellites, CHAMP and Kanoya are selected for a time period from 8 hours 29 39 to 8 hrs 42 32 UT in the dusk sector. For the ST5 spacecraft we compute the scalar field and correct for the IGRF field and CM4 lithospheric field for this time period. The IGRF values are also removed from the ground data and CHAMP data. The data are band passed filtered; the power spectral density consistently shows a very significant peak at around 30 mHz., in all the datasets. The coherence at this frequency between the different datasets is high (86% to 98 %). The band passed data for all the ST5 spacecrafts clearly show the PC3 micro pulsations. A similar exercise using the vector components was also undertaken. Results of the analysis of vector and scalar data of ST5 satellites together with CHAMP and ground data will be presented to isolate the transverse and longitudinal oscillations and identify the spatial and temporal variations of the pulsations in the Pc3-Pc4 range.

Keywords: micro satellites, pc3 pc4 pulsations, low latitude

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ASV037 **Oral Presentation** **3832**

A new magnetic field model for years 2001-2006 based on satellite and observatory vector data

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Most of the core and lithospheric magnetic field models published in recent years are using data on the night side of the Earth to avoid contamination by ionospheric fields. Scalar data are used over the poles in the winter hemisphere only to also minimize the fields generated by field aligned currents. Such data distribution make the separation of internal and external sources of the magnetic field difficult, and constraints have to be applied on the secular variation in order to exclude possible spurious annual effects. To avoid these problems we built a model using exclusively vector data. Furthermore, at high latitudes data at all local times are used. Such data distribution allow us to build over the poles localized models of the fields generated in the ionosphere or by field aligned currents. The core field secular variation model is defined up to Spherical Harmonic (SH) degree 14 and has an acceptable behavior at the core mantle boundary. In particular, we introduced a discontinuity of the core field second derivative in time to model possible effects of the 2003.5 magnetic jerk. The model of the field generated in the lithosphere is defined up to high spherical harmonic degrees using regularization mainly over the poles.

Keywords: geomagnetic field

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ASV037 **Oral Presentation** **3833**

Magnetospheric contributions to the near Earth magnetic field

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Solar wind generated magnetospheric currents constitute a significant source to the magnetic field near the Earth surface. Most prominent and also most well described is the effect of the magnetospheric ring current, but also magnetopause currents, partial ring current and tail currents play a role. Least well describe is probably the long-distance effect of the high-latitude field-aligned currents. When constructing accurate models of the Earth's internal magnetic field, based on data from low-altitude satellites, it is therefore a major problem to eliminate these effects. Even during quiet conditions these currents exist and may introduce significant noise as well as systematic errors in the internal field models. Modelling of these effects is therefore one of the objectives of the Swarm mission. Recent results on magnetospheric contributions to the near Earth magnetic field and their relation to the solar wind parameters are discussed and compared, including both observations, empirical and theoretical modelling.

Keywords: magnetosphere, currents, facs

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ASV037 **Oral Presentation** **3834**

Electrical Conductivity in the Earth's Mantle: Joint inversion of Surface, CHAMP and Oersted Observations

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Global EM induction studies are traditionally based on long-term variations of magnetic elements observed at ground geomagnetic stations Parallelly, geomagnetic field measurements from low-orbit satellites, such as MAGSAT, Oersted, and CHAMP have provided a large improvement in spatial coverage and motivated new research in this area. Complicated spatio-temporal character of satellite data favor the application of time-domain techniques for the global EM induction problem. To make use of both ground and satellite observations, reformulation of the forward problem is necessary.We present a modification of the time-domain, spherical harmonic-finite element approach that is based on a joint use of vector magnetic data from satellites and ground observatories. The Galerkin solution of the EM induction equation in the heterogeneous Earth is complemented by potential fields in two insulating regions. A thin-sheet approximation of the ionosphere is assumed on their boundary, permitting a discontinuity of the horizontal magnetic field. Theboundary conditions are prescribed at the Earth's surface and at the satellite altitude. These can take a form of the spherical harmonic coefficients of external, internal, horizontal or vertical fields. The associated code has been numerically validated against semi-analytical nested-spheres solutions and existing methods.Our database comprises of two segments. The hourly means from 143 geomagnetic observatories from years 2001-5 are processed to time series of spherical harmonic coefficients up to degree 3. The processing involves the exclusion of subpolar stations, removal of the main field, lithosperic field, and secular variations by means of CHAOS model, and the corrections for local baselines. Likewise, night-time data provided by CHAMP and Oersted satellites are processed track-by-track to yield time-series of zonal spherical harmonic coefficients above the ionosphere.To invert data, we employ a simple model consisting of a laterally heterogeneous surface conductance map overlaying a 1-D layered model. Conductivity of the core is fixed at 106 S/m. The misfit of the predicted internal field on the surface and at the satellites is measured in L2 and L1 norms. The method shows good sensitivity to lower-mantle conductivities while it is not conclusive with respect to the upper mantle.

Keywords: mantle conductivity, geomagnetic induction

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ASV037 **Oral Presentation** **3835**

Towards data assimilation in a dynamical model consisting of small scale axial vortices

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Continuous satellite measurements of the Earth's magnetic field have now covered a time interval long enough (1999-2006) to monitor accurately the time changes of the magnetic field. From the inversion of the induction equation at the core surface, we find that motions of smaller lateral lengthscale than previously thought are required to account for the secular variation of the Earth's magnetic field which has been recorded for the last 7 years; consequently, an important part of the large scale secular variation is the result of the interaction between core flows and small scale magnetic fields at the core surface that cannot be inferred from measurements at the core surface or above. We argue that as a result of both the dominance of the Coriolis force in the fast dynamics (because magnetic diffusion is negligible on short timescales) and the small scales of the motions inferred from SV models, the flow within the core is columnar, made of vortices aligned parallel to the axis of rotation. Assuming quasi-geostrophic motions, we write the momentum equation that governs the streamfunction. As this equation involves only quantities (quadratic products of the magnetic field components) that are integrated in z ((s,phi,z) cylindrical coordinates), we can envision to co-estimate these quadratic products with the axially invariant velocity field. This approach requires having the best possible knowledge of the small scale and rapidly varying magnetic field at the core surface. In comparison, the precise measurement of the large scale magnetic field is less crucial. On the one hand, our study is motivated by the perspective of Swarm data. On the other hand, our work suggests that it will be more and more difficult to study separately signals from different sources. Our approach indeed leads to assimilation of geomagnetic observations in our quasi-geostrophic model for the liquid core. In this context, magnetic field models at the core surface are not simply data that can be inverted to describe core motions but rather become the product of the data assimilation in a dynamical model.

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ASV037 **Oral Presentation** **3836**

Use of a method called balloon gradient survey method in scope of implementation of the project named "SWARM"

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The progress of satellite geomagnetic surveys gives an enable to elaborate the joint model of magnetic anomalies in near-Earth space. It should be noticed that a vertical thickness of the Earth's crust makes ~ 40 km. Therefore the crust magnetic field at altitudes of 0-40 km is formed by 3D-source, and at higher altitudes – by 2D-source. Hence, in construction of the common model it is important to have the magnetic data received at heights of 20-40 km. IZMIRAN together with MAI have created balloon magnetic gradiometer. That device has six-kilometer measuring base focused along a direction of gravity (vertical). Gradiometer consist of three scalar magnetometers placed in instrument containers which are carried along a vertical line on a balloon one behind another through 3 km. Each instrument container also has a GPS-receiver and a satellite communication system called "GlobalStar". The balloon during its drift is subject to influence of fluctuations of bearing air current. Natural experiment has shown that deviations of measuring base from a vertical line in drift of a balloon, for this reason, as a rule, do not exceed 5 , but in very rare cases can reach 15 . To avoid influence of this effect on measurements, each container has its own GPS-receiver. It provides observation magnetometers during the moments of the synchronous measurements, necessary for entering amendments on the main magnetic field in measured data. Efficiency of entering of such amendments has been confirmed in experimental flights of balloons with magnetic gradiometer onboard. The main advantages of use magnetic gradiometer at shootings in a stratosphere are the following. First, it is an excluding of the received vertical gradients of components of an external magnetic field and magnetic effects of the geophysical phenomena of the intraterrestrial nature. Secondly, it is a real opportunity of reliable division of the measured magnetic field on normal and abnormal parts. The listed advantages of stratospheric gradient magnetic measurements method allow: to analyze structure of residual satellite magnetic fields and long-wave magnetic anomalies; to create reliable model crust magnetic field for ground space, including Arctic regions and Antarctic; to determine geophysical interpretation of magnetic anomalies for sure. The implementation of the project can be undertaken in creation of model of separate magnetic anomalies based on satellite and balloon magnetic data. In our opinion, implementation of the project stratospheric gradient magnetic shootings in the future is a necessary part of the project "SWARM". Such shootings can become the important add-on in researches on the International geophysical year, because of owing to absence of alternative in Polar areas of the Earth.

Keywords: gradient, magnetic field, abnormal

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ASV037 **Oral Presentation** **3837**

The NGDC geomagnetic field model to spherical harmonic degree 720

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NOAAs National Geophysical Data Center (NGDC) has extensive holdings of marine and aeromagnetic data. Due to the changing main field from the Earths core, and due to differences in quality and coverage, combining these data to a consistent global magnetic model is challenging. CHAMP satellite measurements constrain the main and lithospheric magnetic field at long wavelengths, up to spherical harmonic degree 100 (400 km wavelength), while the near-surface magnetic data provide the shorter wavelength information up to spherical harmonic degree 720, corresponding to 15 arc minute angular resolution. An external field component includes stable and time varying contributions in solar magnetic and magnetospheric coordinates. The resulting model can be used to predict the magnetic field vector at any given point at (or above) the Earths surface. Apart from its use for geoscientific studies, the model can also serve as an accurate magnetic reference for navigation and technical applications.

Keywords: magnetic, field, model

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ASV037 **Oral Presentation** **3838**

Global electromagnetic induction studies in the frame of the SWARM mission

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Although satellite electromagnetic induction studies have usually assumed a symmetric magnetospheric ring current source described by Y10, there is growing evidence for significant source asymmetry. Balasis et al. (2004) and Balasis and Egbert (2006) presented evidence for at least an additional Y21 quadrupole term that introduces some local time asymmetry in the source. This component is correlated with the traditional axial dipole source variations, and oriented so that meridional magnetic fields peak in the dusk sector (at 19:30 LT). The time-domain, spherical harmonic-finite element method developed by Velimsky and Martinec (2005) has recently been applied to 1-D inverse modeling of CHAMP satellite data assuming only storm-time, axially symmetric ring-current excitation (Velimsky et al., 2006). We attempt to apply the method to model the electromagnetic response of the Earth to the source field incorporating higher degree non-zonal terms. It is noted that a multi-satellite mission would offer the opportunity to compare and combine simultaneous measurements over different local times. This could help in mapping more accurately the fields of the system of external currents used for estimating electromagnetic induction transfer functions. Therefore the foreseen SWARM constellation will be essential to the task of developing improved source models for induction studies. Ultimately, data assimilation methods which combine physics-based models of the magnetosphere and ionosphere with all available data offer the greatest hope for accurate modeling of external sources for global induction studies with satellite data.

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ASV037 **Poster presentation** **3839**

Using Satellite Geomagnetism to Probe Ocean Flow

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Dr. Richard Holme, Dr. Rob Tyler

For many years it has been recognised that the passive flow of the circulating oceans through the earths magnetic field, generates a secondary magnetic field through the process of motional induction. However, while this phenomenon is known to exist, little work has been done to characterise these secondary fields. Global flows such as tides have received some attention, but detailed knowledge of the small scale local flow is severely lacking. The focus of this work is on the Argentine Basin of the Southern Atlantic Ocean. While earlier work by other has found evidence of an anti-cyclonic barotropic circulation of 25 day period using TOPEX/POSIEDON altimeter data and bottom pressure measurements, here we attempt to isolate the circulations magnetic signature using a combination of observatory & satellite data with various data analysis methods.

Keywords: geomagnetism, ocean

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ASV037 **Poster presentation** **3840**

The analysis of the time series of the daily spherical harmonic models received according to the satellite CHAMP

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Long-period work of the latest satellite missions and high quality of data allows to use for the first time methods of mathematical statistics for separation of these data into parts of different origin and to create the precisely models of the main magnetic field and its secular variation. Magnetic measurements taken by the CHAMP satellite between May, 2001 and January, 2007 were used to construct the daily spherical harmonic models. A lot of data within a day and uniform its covering of the globe enables the construction of the main field models for n=m= 10. There were no special preliminary selections of data. Time series of coefficients of daily models were processed using the method of natural orthogonal components. This method has divided the total magnetic field measured on the satellite into fields from various sources such as the interterrestrial and solar-dependent external nature. Time changes of each source and the maps of their distribution on the Earth surface are presented. Annual models of the main field and its secular variation for the every year of the mentioned interval are received. The accuracy of these models is no worse than the accuracy of the traditional models. According to the mentioned models power spectra Rn (n=1-6) for almost six-years interval are calculated, their Furje-analysis is made. It is shown that ratio R 1 /R 2 diminishes stably on the all time interval.

Keywords: satellite missions, main magnetic field, spherical harmonic models

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ASV037 **Poster presentation** **3841**

Using the comprehensive model in disturbed conditions.

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The Comprehensive Model uses the potential field approach to represent the magnetic fields produced in the Earths core, lithosphere, ionosphere and magnetosphere (including induction effects). The data set used to generate the Gauss coefficients in the model is chosen for its lack of geomagnetic activity. Nonetheless, it has been informative to compare the model output to observatory data during active periods. The driving inputs for the ionospheric and magnetospheric terms are respectively the f10.7 and Dst indices. Dst in particular allows the model to respond to active conditions outside of the original geomagnetic activity remit. We have tested version 4 of the model (CM4) against global magnetic observatory data during an isolated substorm (15th November 2001) and a storm (19th to 26th November 2003). The response is markedly different; CM4 shows only a tiny effect during the substorm but predicts a large change in the magnetic field in the storm. This can be attributed to the different response of Dst to these two types of large scale geomagnetic phenomena.

Keywords: geomagnetism, comprehensive model, storm

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ASV037 **Poster presentation** **3842**

Ionospheric magnetic field modeling from ground-based and satellite data

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Chulliat Arnaud

The ionospheric magnetic field is generated by electrical currents flowing within the conducting layers of the Earths atmosphere, at about 110 km altitude. These currents vary by day, by season, by solar activity, and also with the main magnetic field of internal origin. The aim of this project is to develop a spherical harmonics model of the ionospheric magnetic field below and above the ionosphere, using magnetic data from low-Earth orbiting satellites such as rsted and CHAMP, and magnetic observatory data. We first focus on quiet-days magnetic field variations at mid-latitudes, assumed to be generated by the ionospheric wind dynamo. These variations are extracted from CHAMP data by subtracting the internal and magnetospheric fields predicted by the POMME 3 model (Maus et al., 2006). A similar processing is applied to observatory data. The inverse problem is then solved with and without observatory data, and for various seasons, solar activity levels and epochs. Preliminary results of this study will be presented.

Keywords: ionosphere, magnetic field modelling

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ASV037 **Poster presentation** **3843**

A case for variational geomagnetic data assimilation

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Cline Eymin, Thierry Alboussire, Elisabeth Canet, Alexandra Pais, Dominique Jault

Secular variation of the geomagnetic field has been measured with a continuously improving accuracy during the last few hundred years,culminating with nowadays satellite data. It is however well known that the dynamics of the magnetic field is linked to that of the velocity field in the core and any attempt to model secular variations will involve a coupled dynamical system for magnetic field and core velocity. Unfortunately, there is no direct observation of the velocity. Independently of the exact nature of the above-mentioned coupled system, and the related observational limitations, the question is debated here whether good knowledge of the magnetic field can be translated into good knowledge of core dynamics. Furthermore, what will be the impact of the most recent and precise geomagnetic data on our knowledge of the geomagnetic field of the past and future? These questions are cast into the language of variational data assimilation, while the dynamical system considered for illustrative purposes consists in a set of two simplified one-dimensional equations for magnetic and velocity fields. This toy model retains, nevertheless, important features inherited from the induction and Navier-Stokes equations: non-linear magnetic and momentum terms are present and its linear response to small disturbances contains Alfvn waves. It is concluded that variational data assimilation is indeed appropriate in principle, even though the velocity field remains hidden at all times; it allows us to recover the entire evolution of both fields from partial and irregularly distributed information on the magnetic field. This work constitutes a first step on the way toward the reassimilation of historical geomagnetic data and geomagnetic forecast. By the time of the meeting, we should also report on the first application of variational data assimilation techniques to a quasi-geostrophic dynamical model of the observed geomagnetic secular variation.

Keywords: geomagnetic secular variation, data assimilation, satellite data

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ASV037 **Poster presentation** **3844**

A continuous model of the Earths magnetic field and its temporal change of the period 1956 to 2006

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Vincent Lesur, Richard Holme

We present an extended version of a previously published time-dependent geomagnetic main field model, the C3FM1 (Wardinski& Holme, 2006). The new version of this model, C3FM2, covers theperiod from 1956 to 2006 and includes annual differences of monthly or annual observatory means. Similar to the previous model the new version is constrained to fit satellite main field models in 1980 and 2006. The end model in 2006 is derived from a continuous model of the period 2001 to 2006 (Lesur et al., 2007). The faith of this modelling approach is to provide a detailed characterisation of the secular variation over the last 50 years. A period in which six geomagnetic jerks occurred. Although we use secular variation estimates to set up the model, we expect external field variations, such as the semi-annual and annual variation, to contaminate these annual first differences. In order tofind the most likely set of Gauss coefficients which account for the observed secular variation and to solve the inverse problem, we apply an iterative least squares approach. Usually, the error covariance matrix within the least squares solving is assumed to be diagonal. However, we set up the error covariance matrix to be non-diagonal. This allows a better distinction between internal field variations and contamination due to external field variations.

Keywords: main field modelling, secular variation

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ASV038 **3845 - 3862**

Symposium
World Digital Magnetic Anomaly Map

Convener : Prof. Dhananjay Ravat
Co-Convener : Mr. Juha Korhonen, Dr. Erwan Thebault

This session will focus on magnetic data, methods, and maps contributing to the World Digital Magnetic Anomaly Map (WDMAM) being prepared at the 1:50 million scale. The WDMAM will represent the total field magnetic anomalies of the Earth's lithosphere at the grid interval of about 5 km (specifically, 3 minutes of latitude/longitude) and altitude of 5 km above the geoid and up to spherical harmonic degree 15 (about 2600 km wavelength). This session solicits contributions that describe the data, methods, merging procedures, and processes taken to arrive at candidate segments for future editions of the WDMAM. Deadline for receiving the new data sets by the WDMAM task force for the first edition is end of June 2006 and the submission of candidate maps/models to the WDMAM committee will take place before the end of September 2006. The contributors may freely choose the methods of merging short as well as long wavelength parts of the field, provided that they are transparent, scientific, and reproducible and are proven robust during the review process. An adequate description of the methods and merging procedures of specific large segments of maps must be included with the candidate models.

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ASV038 **Oral Presentation** **3845**

Magnetic anomalies at Atlantic Ocean under the WDMAM compilation

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Ana Snchez-Mera

The use of marine proton magnetometers provides precise magnetic data, and eliminates the problem of the stability of the platform in measurement (i.e. fluxgate sensor limitation). This information, which exists on a worldwide scale, has been available since the 1960s. Global dataset (i.e.: GEODAS) provides a great amount of historical data but usually lacks of any kind of correction, mainly: no extraction of external field contribution, and no reference field model applied. Nevertheless this data, once visualize, suggests that we have at our disposal a much more useful product than what we could a priori expect. Additionally, a new opportunity is offered with the appearance of the comprehensive model (CM4), developed in order to overcome the problem of separation of spatial as well as temporal variations from observed magnetic field at ground, and satellite levels. The IAGA Task Group for the World Digital Magnetic Anomaly Map (WDMAM) appears as a consequence of an initiative that was to get a reliable magnetic global compilation. This should provide to the scientific community a first class tool to access on subsurface geology. In fact, several approaches are underway from the point of view of the data source: magnetic satellite data, aeromagnetic and marine surveys. This communication treats about the later that is marine magnetic surveys, and particularly will concentrate on the Atlantic Ocean. We have used a marine dataset, with historical cruises, once corrected by using the CM4 model. We have divided the original frame into several sectors, usually 40 x 40, split every track, applied spikes extraction Finally we have performed a statistical level technique which uses as observable the residuals at tie points. This method has proved to be useful, improving the internal coherency of the whole dataset. In this communication we will explain our results, difficulties found and lessons learned along the process.

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ASV038 **Oral Presentation** **3846**

Leveling of marine track-line data in the North Pacific Ocean

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One of the important problems in producing a global magnetic anomaly map is processing of marine track-line data in oceanic areas, which cover 70% of the earth. Original anomaly data have very high offsets mainly due to main field secular variation over a time span of almost 50 years and shorter period external field variations. A comprehensive main and external field model CM4 (Sabaka et al., 2004) can reduce most of these offsets. However, there still remain errors, probably due to inaccuracy of the model and errors in the measurements. An rms of about 50 nT was obtained for the cross-over errors of CM4-reduced anomaly values of more than 6 million track-line data in the north Pacific Ocean, which are available from the U. S. National Geophysical Data Center. I developed a method to further reduce these errors by leveling longer wavelength components. It is difficult to apply a tie-line leveling method by dividing the track-lines into survey lines and tie lines, because the track-lines are randomly oriented in general. In my method, for each data point, a weighted average of differences of neighboring anomaly data from that anomaly value is calculated with weights proportional to the -4th power of the distances from the point. Low pass spatial filtering along each track-line is then applied to the obtained averages with a summed weight for each data point. New anomaly values are obtained by adding the filtered values x 0.5 to the original anomaly values. Cross-over errors with an rms of 33 nT was obtained for the case of Gaussian low-pass filter with a width of 50 km.

Keywords: leveling, marine, track line

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ASV038 **Oral Presentation** **3847**

GeoForschungsZentrum Anomaly Magnetic MAp (GAMMA): A candidate model for the World Digital Magnetic Anomaly Map

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Thbault Erwan, Lesur Vincent, Mandea Mioara

The World Digital Magnetic Anomaly Map (WDMAM) is an ongoing effort towards the mapping of worldwide available aeromagnetic data. It is led by a task force of the International Association for Geomagnetism and Aeronomy (IAGA) and aims at distributing a global map in printed and digital forms. In this paper, we describe in details our candidate model which has to be evaluated by the IAGA task force together with five other candidate maps. After discussing the quality of the available data, we show a simple but effective method applied to successfully process, reduce and merge together individual compilations. The near surface data are corrected using global field models and further refined with a 2D polynomial corrections. After the upward continuation to 5km altitude, data are re-sampled to a 3 minutes grid and merged together. We then calculate a spherical harmonic model up to degree 199 and analyze the magnetic spectrum of the global map. This helps us to confirm that wavelengths larger than 400km are spurious at a global scale in aeromagnetic compilations. Therefore, we substitute them using a satellite based lithospheric field model (MF5) to degree 100. Finally, our proposed candidate map for WDMAM is presented.

Keywords: wdmam, gamma, processing

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ASV038 **Oral Presentation** **3848**

Towards the second generation Antarctic Digital Magnetic Anomaly Map

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Initiated in 1995, the Antarctic Digital Magnetic Anomaly Project (ADMAP) produced the first magnetic anomaly map of the Antarctic region south of 60 deg S (Golynsky et al., 2001). This map incorporated Magsat satellite, and airborne and marine magnetic survey data available up through 1999. Since the production of the initial map, a large number of new airborne and marine surveys have been carried out, and improved magnetic observations from the rsted and CHAMP satellite missions have become available. In addition, an improved core field model for the Antarctic has been developed (Gaya-Piqu et al., 2006). In view of these results, we consider the development of an improved magnetic anomaly map for Antarctic geological studies. The next generation map likely will synthesize the magnetic survey observations of the region in terms of a high-resolution revised spherical cap harmonic model (Thbault et al, 2006). In this paper, we review the progress and problems of developing the new map to facilitate studies of the Antarctic crustal magnetic field.

Keywords: magnetic anomalies, regional modelling, antarctica

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ASV038 **Oral Presentation** **3849**

Magnetic anomaly map of the world: merging satellite, airborne, marine and ground-based magnetic data sets

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Erwan Thbault, Mioara Mandea, Stefan Maus

We present a simple but practical method to combine systematically the magnetic surveys of disparate specifications from marine, ground, aeromagnetic and satellite platforms. The resulting global magnetic anomaly grid is submitted as a candidate model for world digital magnetic anomaly map project. Because the satellite coverage and data quality is more uniform than near-surface surveys, it is adopted as the base map for wavelengths larger than 400 km and up to spherical harmonic degree inclusive of 16 (~ 2500 km). We use the latest, MF5, in the series of maps derived using CHAMP satellite scalar and vector magnetometer data. After checking that satellite models and large aeromagnetic wavelengths are not consistent, we filter out wavelengths longer than 400 km in aeromagnetic compilations. Existing regional grids and, when available, individual surveys, are merged to give a more uniform spatial variation of the magnetic anomalies. The effects of merging the grids are examined by plotting profiles and difference map of the overlapping regions. The final global map is obtained after combining aeromagnetic magnetic anomaly map with the downward continued MF5. Forthcoming availability of new datasets as well as improvements in the procedure will help to produce increasingly reliable global magnetic anomaly maps.

Keywords: aeromagnetic, satellite, merging

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ASV038 **Oral Presentation** **3850**

Magnetic anomaly compilation for Argentine continental margin studies

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As part of a project to study the Argentine continental shelf and margin we are working on the compilation of several magnetic data sets in the region within the geographic bounds 35- 50 S, 70 - 50 W, which comprises the continental shelf and reaches the Cretaceous Quiet zone in the southern South Atlantic Ocean. The first and most extensive data set corresponds to the aeromagnetic survey of the Argentine platform known as ARGUS project, jointly developed by the U.S. and Argentine navies in two deployments, April 1991 and September 1993. Another important set is the magnetic data from a Geophysical cruise performed by the Federal Institute for Geosciences and Natural Resources(BGR, Germany) in two phases, December 1998 and January 1999 (BGR98). Other data are from earlier BGR cruises performed in 1987 and 1993. We have also included marine magnetic data from the GEODAS Marine Trackline Geophysics database (NGDC, NOAA).One important task to address in a compilation is to check the intervening data sets for consistency. Although ARGUS and BGR data were already in good self consistent shape, we re-processed them individually to minimize internal cross-over errors (COEs). The merging procedure between these two sets involved further cross-over analysis. ARGUS-BGR98 cross-over errors yielded a mean value of 22.5 nT prior to correction and a standard deviation of 16.7 nT for 261 cross-overs. This was reduced after statistical leveling to 0.0 and 8.9, respectively, thus obtaining a satisfactory merged data base for the two surveys. The incorporation of the other BGR cruises (smaller in extent) was performed using the ARGUS-BGR98 merger as a reference.The integration of the GEODAS data was more problematic, and it is still work in progress. The 231 such cruises with tracks in our study area have been edited, eliminating obviously bad values and splitting the tracks at sharp course changes, and magnetic anomalies have been re-calculated using DGRFs. COEs correction is particularly difficult in this case, as for old cruises navigation errors are important. The ARGUS-BGR compilation was used as reference. Once the COEs were found, a line by line correction was applied.In this presentation we display maps and document procedures. The new data addition considerably improves our previous on-shore - off-shore compilation. The Mesozoic magnetic lineations can be much better identified: particularly anomaly M3 stands out for its very clear definition. Margin parallel conspicuous anomalies attributed to volcanic activity during break-up are better delimited, a negative tail marking their abrupt SW ending at the Colorado offset. A detailed history of the entire effort can be found at http://ggt.conae.gov.ar/iaa/pictr2002/.

Keywords: magnetic anomaly, compilation, volcanic margin

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ASV038 **Oral Presentation** **3851**

Reuniting Gondwanaland with transformations of the World Digital Magnetic Anomaly Map (WDMAM)

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Colin Reeves, The Wdmam Team

The World Digital Magnetic Anomaly Map (WDMAM) makes it possible to evaluate competing hypotheses and reconstructions of continental and oceanic assemblies of most regions of the world and understand their geologic evolution. However, magnetic anomalies contain effects of changing inclination, declination, and inducing field intensity and must be normalized prior to realistic assessment of geologic reconstructions. For the WDMAM, with over 25 million points, this is an enormous computational effort even for modern day computers. We investigate the efficacy of approaches such as field- normalized reduction-to-pole of the magnetic anomalies, magnetic susceptibility contrasts, and the total gradient field (Analytic Signal) mapping in evaluating the assembly of Gondwanaland. We also assess the improvement in our geologic understanding of these regions due to the availability of the WDMAM.

Keywords: magnetic anomalies, geology, gondwanaland

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ASV038 **Oral Presentation** **3852**

World Digital Magnetic Anomaly Map (WDMAM), 2007 Edition

Mr. Juha Korhonen
IAGA

Colin Reeves, Stefan Maus, Susan Mclean, Mioara Mandea, Michael Purucker, Tamara Litvinova, Peter Milligan

WDMAM is an international scientific joint effort supported by IAGA and CGMW to compile and publish a reliable world map of magnetic anomalies that are attributable to the Earths uppermost lithosphere. The data are derived mostly from the multitude of aeromagnetic surveys executed over the continents in past decades and ship cruise data over the oceans. All data are referenced to satellite magnetometer measurements and geomagnetic observatories in a comprehensive way for the first time. The work is designed to attract users from the geological community to the value of magnetic anomaly data in the exploration of the earth, its tectonics and resources.The results have been presented as a printed magnetic anomaly map of the World at scale 1:50 000 000 (consistent with Geological Map of the World by CGMW) and a digital database that includes anomaly values on a grid of resolution 3 arc minutes (about 5 km at the equator). The nominal observation altitude is defined at 5 km above the geoid. Wavelengths longer than about 2600 km have not been included.Data has been provided from open sources of continental grids such as for North America and Australia and oceanic profiles held by various agencies. As-yet-unpublished continental-scale grids were invited from Russia, India, Argentina, South Africa, and several European countries. Global reference data was obtained from CHAMP measurements and the MF5-model (Maus et al. 2006). Map compilation methods were developed within five international teams that prepared seven candidate maps (Hemant et al., in press, Maus et al., in press, Hamoudi et al., in press). The final map is a combination of the work of all teams.The magnetic anomaly map (First Edition) has been released at IUGG2007 in Perugia, July 2007 (this meeting). An updated anomaly map and a calculated magnetization map is planned for the 33rd International Geological Congress in Oslo, August 2008.References: Maus, S., Lhr, H., Rother, M., Hemant, K., Balasis, G., Ritter, P., and Stolle, C. Lithospheric magnetic field modeling from CHAMP satellite measurements, submitted for publication in the proceedings of the geomagnetism workshop, Braunschweig, Germany, October 2006. Hemant, K., Thebault, E., Mandea, M., Ravat, D., and Maus, S. Magnetic anomaly map of the world: merging satellite, airborne, marine and ground-based magnetic data sets. Submitted for publication in Earth and Planetary Science Letters, August 2006.Maus, S., Hemant, K., and Fairhead, D. The NOAA candidate for the World Digital Magnetic Anomaly Map. Submitted for publication in G3 November 24 2006. Hamoudi, M., Thebault, E., Lesur, V., and Mandea, M. GeoForschungsZentrum Anomaly Magnetic MAp (GAMMA): A candidate model for the World Digital Magnetic Anomaly Map" Submitted for publication in G3 December 8, 2006.

Keywords: magnetic, anomaly, world

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ASV038 **Oral Presentation** **3853**

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As agreed in Sapporo 2003 and confirmed in Toulouse 2005 the First Edition of WDMAM would be combination of existing major grids, completed with newly available data sets, and gaps filled with MF3. This latter was first changed to MF4 and finally to MF5. New reductions of total field data would be done by CM4 or comparable methods. Compilation method of candidate grids would be freely chosen, provided that the procedure is scientific, transparent and reproducible. Common procedure: Data was submitted to GTK, where it was reformatted, smoothed by upward continuation to 5 km and/or re-gridded to 5 km resolution, and transformed to WGS84 geographic coordinates. Originally received and transformed files were uploaded to ftp for use of five international teams. All teams provided additional versions of data to common pool. GTK procedure: Metadata and anomaly calculation schemes were checked. Linear regression and correlation were calculated between MF5 and each grid or sub-grid. Zero degree constant of regression was selected as the new baseline of the anomaly. Coinciding grids were ranked by correlation coefficient. Differently smoothed data sets could not be compared in this way. Highest correlating grids were laterally knitted in 50 km wide border zones. Random profiles were presented in bands of 50 km. Background was substituted by MF5, where no other information existed. Different resolution areas of information were separated by boundaries on the map: 5 km / 25 km / 400 km. Grid cells of overall global combination were flagged by set ID. All data sets were presented on a 0.05 degree grid both as Geosoft database and xyz-file.Three CGMW map windows were compiled from data and presented on 1:50 000 000 layout. Data layers top to bottom: 5 km resolution data grids/25 km resolution data grids interpolated to 5km WDMAM grid/Random profiles, 5 km resolution, 50 km band /400 km altitude satellite grid (MF5) / interpolated to 5 km WDMAM grid

Keywords: magnetic, anomaly, world

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ASV038 **Oral Presentation** **3854**

The Magnetic Anomaly Map of Australia – development, current calibration survey, products and interpretations

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After 60 years of aeromagnetic surveying across , Geoscience is now the custodian of a unique publicly-available continental-scale airborne magnetic database. A derived subset of this database is the Magnetic Anomaly Grid Database of Australia (MAGDA), from which composite grids and image maps can be generated at a variety of resolutions to suit many purposes, ranging from broad continental interpretations to investigations of small, detailed prospective areas. A major product is the continental composite grid and associated Magnetic Anomaly Map of Australia. Intermediate wavelengths (100 km to 400 km) in composite grids have significant errors due to the lack of control available during merging. Control lines of the AWAGS (Australia-wide Array of Geomagnetic Stations) survey flown in 1990 have significantly improved the intermediate wavelengths, and a new AWAGS2 (Australia-wide Airborne Geophysical Survey) project, as part of a recent Australian Government energy initiative, is currently acquiring new baseline gamma-ray spectrometric and magnetic calibration data with a 75 km line spacing and an 80 m terrain clearance. Standard derivative products are easily generated from the MAGDA database, and current research is focussed on generation of accurate depths-to-basement interpretations of prospective areas, better definition of sedimentary basins for petroleum prospectivity evaluation, and interpreted depths to the bottom of magnetic sources in attempts to define the Curie point isotherm. Potential field data also provide important constraints for three-dimensional geological modelling; initial 3D geological models are simultaneously inverted for the secondary variables of mass density and magnetic susceptibility.

Keywords: magnetic anomaly, continental scale, airborne magnetic database

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ASV038 **Poster presentation** **3855**

Geomagnetic reference field models on the Romanian territory and their space-time dynamics as inferred from ground and satellite data

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Space-time dynamics of the geomagnetic field still represents an open question in the attempt to build up consistent geomagnetic images over large areas based on ground or near-surface achieved geomagnetic data. Two synoptic images of the geomagnetic field over the Romanian territory are currently available: the Ground Vertical Component Geomagnetic Map (VCGGM), and the Airborne Geomagnetic Map (AGM). Both models exhibit some qualities and inconsistencies. The main deficiency of VCGGM is the scarcity of data that makes the model highly inaccurate in areas of large horizontal gradients. Besides, as the data acquisition process lasted for about 30 years (from 1950 to 1982), the ground model faces a lot of problems generated by the secular variation (SV) of the geomagnetic field. The AGM is based on a denser and more homogeneous survey network over the whole Romanian territory and a shorter time-span for acquisition campaigns. However, it also faces some inconsistencies. The airborne survey mainly consisted in flight panels of constant altitude (generally at 300 meters over the highest topography in the panel). Space inconsistency is provided by various flight altitudes (ranging between 100 to 2900 meters) of different panels. Time inconsistency occurs within data set due to SV effect generated by the time-span of data acquisition (from 1962 to 1968). DYGEF is a recently funded project by the Romanian Authority for Scientific Research mainly aimed at removing AGM inconsistencies. Based on thorough studies on the space-time dynamics of the Earth magnetic field over the Romanian territory, a specific methodology able to remove the above-mentioned space - time inconsistencies will be obtained and applied to the previously gathered airborne geomagnetic data in order to achieve consistent geomagnetic models for the Romanian territory integrated into the European and global framework. Among major problems, the research focused on distortions provoked by the geomagnetic reference field models so far used in computing the geomagnetic anomaly on the Romanian territory. The paper deals with problem of choosing the most appropriate reference field for the Romanian territory among the numerous models provided by the scientific community. Qualitative / quantitative comparative analysis of various global and local (normal) available reference models is made. DGRF, WMM and other satellite-based models are compared each other and then compared with models constructed on the basis of ground observations as provided for several epochs by the Romanian SV Network and the Geomagnetic Reference Network for the construction of the VCGGM. Time-series provided by the Surlari Geomagnetic Observatory are also taken into consideration while studying the SV impact. The present research has been partly funded by the Romanian National Authority for Scientific Research through the grant CEEX-X2C18/2006.

Keywords: geomagnetic, dynamics, satellite

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ASV038 **Poster presentation** **3856**

On estimating high-degree crustal field models using Spherical Harmonic Transforms

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Estimating Spherical Harmonic models of the crustal field by Least-Squares fit to the observations is very slow and computer ressources expensive if expansion coefficients of degree larger than n = 100 or so are derived. In order to describe small-scale features of the crustal field, several alternatives to global spherical harmonic models, like Rectangular Harmonic Analysis and Spherical Cap Harmonic Analysis, are therefore in use. Inherent to most of these regional methods are, however, inaccuracies when performing external/internal field separation and upward/downwnard field continuation. A global spherical harmonic expansion does not suffer from these problems (since its basis functions, the spherical harmonics, solve the Laplace equation). An alternative to the very time consuming fit of the raw observations is an iterative approach, based on a Spherical Harmonic Transform. Iterations are needed to account for different altitudes of the observation points. We will report on some experiments to derive crustal field models up to degree n = 900 using this approach. The results could be of interest in for the World Digital Magnetic Anomaly Map (WDMAM), and for regional crustal field resolution enhancement of the Comprehensive Model.

Keywords: lithospheric field, spherical harmonic transform, wdmam

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ASV038 **Poster presentation** **3857**

Digital maps of the magnetic anomaly components of the Baltic.

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A systematic magnetic component survey on the Baltic Sea was carried out in the years 1970-1990, during 9 expeditions on the non-magnetic schooner "Zarya". Geomagnetic components horizontal (H), vertical (Z), declination (D) and total (T) were measured. The total length of the profiles during all expeditions was about 56643 km. The distance between profiles averages 1-2 NM (nautical miles). The instrumental, deviation and variation corrections were included to all results of measurements. The variation corrections were determined on the grounds of the data from magnetic observatories located around Baltic. Original technique was suggested to reduce the data to the epoch 1990. As a result, the interpolation of the data into the knots of a regular network 1x1 km was performed. The digital maps of components were used to separate the anomalous magnetic field. The problem of constructing approximating surfaces on the data of digital maps by least-square procedure falls into the category of incorrect one. It is due to the geometric shape of the sea. The data of 10 magnetic observatories were involved to reduce an edge effect. Surfaces of the 3-rd order were calculated on the data of digital maps. Anomaly maps of T and H were calculated by two ways: on the corresponding component map directly and on the anomaly maps of potential components (X, Y, Z). Although as it is known the total field is close to the Z component in high latitudes the results obtained by two methods differ essentially.

Keywords: anomaly maps of baltic

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ASV038 **Poster presentation** **3858**

Circum-Arctic Mapping Project: new magnetic anomaly map of the Arctic (to 64/60 degrees N)

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An international effort to compile Circum-Arctic geophysical and bedrock data is currently being conducted by several national agencies (Russia, Sweden, Finland, Denmark, USA, Canada and Norway). This project aims to produce an atlas that will comprise geological and geophysical digital maps at a scale of 1: 5 million for the Arctic region limited by the 64 degree North latitude (and 60 degree North latitude for the NW Europe and Canadian regions). New published and classified magnetic and gravity anomaly gridded data from each participant group were gathered and converted to a common datum and format. The magnetic anomaly compilation relies on 1km gridded data for Canada (based on the Canadian Aeromagnetic Data Base), Alaska (based on Alaska USGS aeromagnetic database) and NW Europe (Fennoscandia compilation and the NGU NE Atlantic compilation) regions, and 5 km gridded data for oceanic and Russian regions. The grids have been merged using two separate methods: the GEOSOFT routine GridKnit and an alternative method proposed by Hemant et al. (2007). The final grid resolution of this compilation will be 2x2 km upward continued to 1 km. Preliminary Circum-Arctic magnetic anomaly maps will be presented and technical details will be discussed. As the input gridded data contain improved national geophysical datasets compared to previous compilations (Verhoef et al., 1996 Arctic/North Atlantic and Glebovsky et al, 1999 Arctic ocean magnetic anomaly compilations) we consider that the new product will supplement the WDMAM compilation and make a substantial contribution to the geoscientific community.

Keywords: circum arctic, magnetic, anomaly

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ASV038 **Poster presentation** **3859**

Analysis and processing of marine magnetic measurements to construct a magnetic anomaly grid at regional scale

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Proposed grids for the World Digital Magnetic Anomaly Map (WDMAM) are compiled and treated from aeromagnetic, marine, and satellite magnetic measurements. On continents, the large number of aeromagnetic surveys strongly constrains the accuracy of the grids, even if, sometimes, the map boundaries display severe contrasts. On oceans, raw marine data are used and gaps between tracks have to be interpolated. However, a careful process has to be chosen, in order to introduce no spurious anomalies. Furthermore, classical post-acquisition numerical techniques are not completely adapted for re-levelling cross-over tracks of different surveys. Here a careful processing of the raw marine magnetic data in the specific area of the Walvis Ridge (west to Namibia South Africa) is performed to produce an acceptable grid of total intensity magnetic anomaly at sea-level, and then at 5 km altitude. Preliminary results are presented and the improvements in modeling discussed.

Keywords: magnetism, marine, interpolation

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ASV038 **Poster presentation** **3860**

Spectral Analysis of the Global Lithospheric Magnetic Anomaly Field derived from Airborne, shipborne, and satellite Data

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Several candidate grids were submitted for evaluation in the framework of the World Digital Magnetic Anomaly Map (WDMAM) project. A standard way of evaluating the final grids is to compare them with original gridded data in order to verify that the geomagnetic information have been properly secured during the final stage of the processing. Nevertheless, the original data and grids used for the WDMAM have themselves heterogeneous qualities and resolutions and the lack of metadata information about the raw data makes it difficult to assess the consistency and the resolution of the magnetic anomalies everywhere.In this paper, we use the Geoforschungszentrum MAgnetic Anomaly Map (GAMMA) candidate grid as an input to derive a spherical harmonic model to degree and order 500 .The harmonic decomposition allows to analyze the global magnetic spectrum of the map. The results are then compared to local wavelet spectral analysis of the grid in order to find out the effective spectral content of the WDMAM and to obtain some constrains on the source depths and Curie isotherm determination. This extra information will prove useful for more cautious geological interpretations based on the WDMAM grid.

Keywords: wdmam, gamma, spectrum

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ASV038 **Poster presentation** **3861**

The NGDC candidate for the World Digital Magnetic Anomaly Map

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Marine and airborne magnetic anomaly data have been collected for more than half a century, providing global coverage of the Earth. Furthermore, the German CHAMP satellite is providing increasingly accurate information on large-scale magnetic anomalies. The World Digital Magnetic Anomaly Map (WDMAM) project is an international effort to integrate all available near-surface and satellite magnetic anomaly data into a global map data base. Teams of researchers were invited to produce candidate maps using a common pool of data sets. Here we present the NGDC candidate. To produce a homogeneous map, the near-surface data were first line-leveled and then merged by Least Squares Collocation. Long wavelengths were found to agree surprisingly well with independent satellite information. This validates our final processing step of merging the short-wavelength part of the near-surface data with long-wavelength satellite magnetic anomalies

Keywords: magnetic, anomaly, map

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ASV038 **Poster presentation** **3862**

Visualized combination of IGRF and local geomagnetic data in China

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Using the geomagnetic survey data in China during last 60 years, we made some effort to establish a visual model more close to real geomagnetic fields in China area than IGRF. We try to put this model on the website so that geophysicist can view the geomagnetic field through INTERNET with little error.

Keywords: igrf, geomagnetic model, local field

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ASV039 **3863 - 3912**

Symposium
Use of geomagnetic data and indices in space weather and space climatology

Convener : Dr. Juan Jos Curto
Co-Convener : Dr. Renata Lukianova, Prof. Kalevi Mursula

Magnetometers are routinely used on the ground, throughout the magnetosphere and in the solar wind to gather information on rapidly changing space environment conditions. Ground based magnetic observatories also provide an important long time series of data for monitoring conditions over many solar cycles. Such a global database and time span allows us to explore both short term space weather and long term space climatology. In this session we solicit papers that address issues in geomagnetic data and index analysis such as: space weather event detection; methods of classifying geomagnetic activity (e.g. storm severity); derivation of geomagnetic indices (both traditional and new); applications of data and indices for academic and commercial purposes; geomagnetic data mining, analysis, assimilation and visualisation; the short and long term variability of the space environment and of space weather; and climatological models of magnetospheric and ionospheric current systems and fields.

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ASV039 **Oral Presentation** **3863**

Solar proton events and geomagnetic storms relationships during solar cycle 23

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Geomagnetic storms have a good correlation with solar activity and the great solar proton events. Geomagnetic storms correlate with the transparency of the earths atmosphere too. The present work concerns the study of the great solar proton events during the solar cycle 23 and its relation with the geomagnetic storms, from studying the variability of solar and geomagnetic indices. Studying the data of solar and geomagnetic storms, will give us a good indication of the climatic change and its behavior during the future solar cycles.

Keywords: geomagnetic storm, great solar proton event, solar geomagnetic undices

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ASV039 **Oral Presentation** **3864**

Statistical characteristics of the day-to-day variability in the geomagnetic Sq field

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Day-to-day variability of the geomagnetic Sq field is studied by using the magnetic data from a meridian chain of magnetometers along 1200 E longitude. The method of Natural Orthogonal Components (NOC or eigenmode analysis) is applied to separate the Sq variation from complicated disturbances. The first eigenmode with the largest eigenvalue represents fairly well the Sq variation with a conspicuous day-to-day variability in the daily range. For the stations on the same north- or south-side of the Sq current system focus, the day-to-day variations show a positive correlation. In contrast, for the stations on the different sides of the Sq focus, they show a negative correlation, suggesting an important role of latitudinal shift of the Sq current system focus to the day-to-day variability of the Sq daily range. The Sq daily range is correlated with the magnetic indices Ap and Dst in a peculiar way: on some severe disturbed days, noticeably enhancements of the Sq are observed, implying increases of the ionospheric conductivities and/or tidal wind velocities; on other severe disturbed days, however, dramatically reduced Sq variations occur, suggesting dominant effects of the disturbance dynamo process.

Keywords: sq, day to day variability, ionospheric current system

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ASV039 **Oral Presentation** **3865**

Analyzing the April 2000 and October 2001 magnetic storms using ground and satellite observations

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The coronal mass ejection (CME) of 4 April 2000 hit the Earths magnetosphere on 6 April. The strong interplanetary southward BZ caused a large magnetic storm. We analyzed this sequence of events using observations of several satellites in the solar wind and at geostationary orbit as well as ground-level magnetometer recordings at various latitudes. In particular, magnetic field data from the IMAGE magnetometer chain in Scandinavia, as well as information form magnetic observatories in southern Africa will be compared. The use of geomagnetic indices, in particular AU, AL, and AE will be used to compare magnetograms in high-latitude regions. The interplanetary magnetic field had an intense and long-sustained southward orientation, while the solar wind pressure was very large, compressing the dayside magnetopause inside the geostationary orbit for more than 6 hours. During the main phase of the storm it was found that several activations were not associated with particle injections, but were directly driven perturbations due to variations in the solar wind. Pi2 pulsations as recorded at Hermanus further showed that the development of the entire storm was quite independent of substorm activations. On the other hand the magnetic cloud event of October 2001 resulted in a series of sawtooth oscillations, observed by satellites at geostationary orbit while magnetograms from ground level also display similar characteristics. In this investigation we utilized data from the CLUSTER satellite mission to investigate the behaviour of ions like oxygen, and helium, as well as magnetic fields during a period around 22 October 2001, characterized by a period of steadily depressed Dst. The SYM-H and ASY-H indices will be correlated with observations. MHD calculations utilizing the BATSRUS code, using solar wind data as input, will be used in our analysis of both geomagnetic storms.

Keywords: geomagnetic, storm

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ASV039 **Oral Presentation** **3866**

The polar cap magnetic activity (PC index) as an indicator of current state of the magnetosphere

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The PC index estimates the polar cap magnetic activity generated by the solar wind and embedded magnetic field. Unification of the calculation procedure for indices derived on basis of magnetic data from stations Thule (PCN) and Vostok (PCS) [Troshichev et al., JGR, 111, A05208] made it possible to obtain the unified PCS and PCN indices, which are well consistent with one another in their value and behavior and linearly correlate with the geoeffective interplanetary electric field (Em). The statistical examination of the PC index response to Em variations and sudden changes in the solar wind dynamic pressure displayed the following regularities. The geoeffective interplanetary electric field Em determines behavior of the PC index, which value is directly influenced by the Em increase with delay time about 15 30 min. The solar wind pressure growth rate (i.e. jump power $\Delta PSW/\Delta t$) appears to be the second most important factor for the PC index increase, the pressure gradient $\Delta PSW = 1$ nPa being approximately equivalent to action of Em = 0.33 mV/m. The pressure growth rate seems to be the alone factor for the PC index increase under conditions of the northward IMF BZ and for the PC index decrease after the negative dynamic pressure jump. The summer PC index increases quicker and reaches the greater value than the winter PC index under any conditions. The relations of the polar cap magnetic activity to magnetic disturbances in the auroral zone (AE/AL/AU indices) has been examined for both isolated and periodical magnetic substorms. The statistical analysis of sudden auroral magnetic disturbances occurring on the background of the quiescent magnetic field showed that the sudden onset is preceded by growth of the PC index during the foregoing growth phase (for 1 hour previous to substorm onset). The PC index in summer polar cap (the summer PC) turned out to be growing much faster than that in the winter polar cap and reached, by time of the sudden onset, a higher value than the winter PC index, irrespective of the disturbance intensity. After the sudden onset (during the expansion phase) the summer PC index changes slightly (or even decreases in cases of long substorms), contrary to the winter PC index that changes in conformity with the course of the magnetic substorm. The results give evidence that the summer PC index, being mostly affected by the geoeffective interplanetary electric field, is not responding to the auroral disturbances. The periodical (sawtooth) substorms represent a good illustration of linkage between the incoming energy and the substorm intensity in cases of long impact of a geo-effective solar wind. Substorms occur if the growing PC index exceeds a value of ~ 2 mV/m during tens minutes. The substorm onsets follow the PC enhancement with a delay in the range 15 - 60 minutes, if the PC index remains less 4 mV/m. With further increase of the PC index the average delay time is shortened and can fall to zero, if the PC value exceeds 6-8 mV/m. A decrease of the PC index to a level lower than 2 mV/m is definitely followed by substorm decay. Thus, the PC index demonstrates two important peculiarities: Firstly, the index adequately responds to geoeffective changes in the solar wind parameters, and therefore it can be regarded as a characteristic of the solar wind energy transferred into the magnetosphere. Secondly, the PC enhancement anticipates the substorm development, the substorm intensity being dependent on the preceding PC level. In such a manner, the PC index can be used as a reliable tool for the magnetosphere current state diagnosis.

Keywords: polar cap, magnetic, activity

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ASV039 **Oral Presentation** **3867**

Determination of ground conductivity and system parameters for optimal modeling of geomagnetically induced current flow in technological systems

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Risto Pirjola, Ari Viljanen

In this work, methods to determine technological system parameters and the ground conductivity structure from different sets of geomagnetically induced current (GIC), magnetic field and geoelectric field observations are explored. The goal of the work is to enable optimal modeling of induced currents in any technological system experiencing GIC. As an additional product, the introduced methods can also be used to utilize GIC observations in the imaging of the subsurface geological structures. The application of the methods to data obtained for a storm period of October 24-Nov 1, 2003 demonstrate that optimal system parameters and ground conductivity structure can be obtained using time series comprising only 8 days worth of data. Furthermore, it is shown that although in an ideal case the GIC and magnetic field data should be obtained from the exactly the same spatiotemporal location, some spatial separation (200-300 km) between the GIC and the magnetometer sites can be tolerated.

Keywords: geomagnetically induced curren, modeling, inversion

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ASV039 **Oral Presentation** **3868**

On a role of global Pc5 oscillations in the magnetosphere dynamics during geomagnetic storms

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Global Pc5 oscillations are the most intense geomagnetic pulsations that occur during powerful magnetospheric storms. They are well known to play a significant role in the magnetosphere dynamics and space weather processes. Acceleration of relativistic electrons is provided by these oscillations. In the previous work reported at the X Scientific Assembly of IUGG in Toulouse we studied correlation of global Pc5 events with the super fast solar wind streams, resonance structure of Pc5 waves, and statistics of their amplitudes and periods. The present research is devoted to another side of global Pc5. The role of these pulsations in the processes that take place in the disturbed magnetosphere has been under investigation. To do that, we used datasets from the INTERMAGNET worldwide network completing them by the interplanetary and intramagnetospheric magnetic and plasma data, as well as the Kp, Dst, and AE indices. Using these data energy input into the magnetosphere and dissipation of the energy in the ionosphere during Pc5 events were examined. Results show a complicated picture of the ULF waves participation in the processes of energy entry and drain in the magnetosphere. Usually Pc5 event occurs when Bz component of the interplanetary magnetic field is positive. Nevertheless the magnetosphere maintains its disturbed state. This fact testifies to some additional source of energy inflow to the magnetosphere. The work was supported by RFBR grants 06-05-64143 and 07-05-00696 and INTAS grant 06-1000013-8823.

Keywords: ulf oscillations, geomagnetic storm

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ASV039 **Oral Presentation** **3869**

Predicting the Dst and AL Using Solar Wind Parameters

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Geomagnetic indices, extracted from measurements of Earth's magnetic field and its variations at different time scales, provide the average characteristic of the geomagnetic activity and are an integral part of most studies of space weather. Since the solar wind controls magnetospheric dynamics to a large extent, measurements of the solar wind upstream of the Earth can be used to predict the variations of the magnetosphere. We have developed a model to predict rather accurately the Dst index, an hourly index, based on solar wind measurements. However, on shorter time-scales magnetospheric activity is much less predictable. We demonstrate this by using two recently developed empirical models (one simple and one complex) to predict the AL index, a measure of the Earth's auroral activity derived from magnetometer stations in the Northern hemisphere. Though both models were optimized to predict the 10-min averaged AL index, both models predict a longer-averaged AL index very well while predicting the difference between 2-hour averaged AL and the 10-min AL poorly (prediction efficiency of 0.083 and 0.136 respectively), implying much less predictability for shorter time-scale variations. The models show that the AL index is strongly dependent on the solar wind magnetic field and velocity but is practically independent of the solar wind density.

Keywords: dst, al, prediction

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ASV039 **Oral Presentation** **3870**

ULF Wave Power Indices for the Space Weather Applications

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The solar wind-magnetosphere interaction has a turbulent character, which is not accounted for by commonly used geomagnetic indices and OMNI parameters. To quantify the level of low-frequency turbulence/variability of the geomagnetic field, IMF, and solar wind plasma, we have introduced ULF wave power indices. These simple hourly indices are based on the band-integrated spectral power in the range 2-7 mHz or wavelet power with time scales ~10-100 min. The ground geomagnetic wave index has been produced from the data of global magnetometer arrays in the northern hemisphere. The interplanetary and geostationary wave indices have been calculated using magnetometer and plasma data from interplanetary and geosynchronous satellites. These indices have turned out to be useful for statistical analysis of various space weather problems. For example, the enhancements of relativistic electrons at the geosynchronous orbit were not directly related to the intensity of magnetic storms, but they correlated well with intervals of elevated time-integrated ULF wave index. This comparison confirmed the importance of magnetospheric ULF turbulence in energizing electrons up to relativistic energies. The use of the ULF indices has enabled us to construct with the multi-regression analysis a path diagram, which gives a complete description of the relative importance of interplanetary parameters in driving the ground ULF activity. In addition to the presented problems, a wide range of space physics and geophysics studies will benefit from the introduction of the ULF wave indices. The ULF index database is freely available via anonymous FTP for all interested researchers for further validation and statistical studies.

Keywords: ulf waves, relativistic electrons, space turbulence

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ASV039 **Oral Presentation** **3871**

Variation of Magnetospheric Dynamics During the Solar Cycle

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Geomagnetic indices have been constructed to characterize/describe the magnetospheric state. Signatures of the solar cycle and the underlying solar wind/magnetospheric interaction are reflected in these indices. In order to study the long-term variability of magnetospheric dynamics, we have considered the nonlinear dependencies inherent to the Kp data stream from 1932-present. We find that the dynamics of the magnetosphere tend to be more linear at solar maximum than at solar minimum. The strong nonlinear dependencies tend to peak on a timescale around 40-50 hours and are statistically significant up to one week. Because the solar wind driver variables, VBs and dynamical pressure exhibit a much shorter decorrelation time for nonlinearities the results seem to indicate that the nonlinearity is related to internal magnetospheric dynamics. Moreover, the timescales for the nonlinearity seem to be on the same order as that for storm/ring current transport. In the descending phase of the solar cycle just prior to solar minimum, when magnetospheric activity is weaker, the dynamics exhibit a significant nonlinear internal magnetospheric response that appears to be related to increased solar wind speed. To investigate this effect further, we analyzed nonlinear dependencies during 1995-1996 when a series of high speed stream interfaces were detected in the solar wind, and we discuss the physical origin of the nonlinear response.

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ASV039 **Oral Presentation** **3872**

The long-term variation in the correlation between solar and geomagnetic activity, and its implications for the solar dynamo theory

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For quantifying the long-term variations in geomagnetic activity, geomagnetic aa index is commonly used, and sunspot number is used as a measure of the solar activity because these are the indices with the longest available records. It has long been known that geomagnetic disturbances are caused by solar activity. However, the correlation between aa and sunspot number in the 11-year solar cycle has been decreasing in the last century, while the lag between their maxima has been increasing. aa can be divided into two components: one due to the solar toroidal field (whose manifestations are sunspots and coronal mass ejections, the main source of geomagnetic activity in sunspot maximum), and another due to the solar poloidal field (related to solar coronal holes from which fast solar wind originates, the driver of recurrent geomagnetic activity on the declining and minimum phase of the sunspot cycle). The cyclic transformation of the poloidal field into toroidal field and of this toroidal field into a new poloidal field with the opposite polarity the solar dynamo, is the basis of solar activity. The flux transport dynamo mechanism requires a meridional circulation with a surface flow toward the poles where the poloidal flux accumulates, sinks to the base of the solar convective zone, and is carried by the deep counterflow there back to low latitudes where it is transformed into toroidal flux and emerges as the sunspots of the new solar cycle. Here we demonstrate how the long-term variations in the solar meridional circulation can be derived from the variations in the correlation between aa index and sunspot number, and investigate the role of the meridional circulation for solar activity, geomagnetic activity, and terrestrial climate.

Keywords: geomagnetic activity, solar meridional circulation, global change

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ASV039 **Oral Presentation** **3873**

On the use of magnetic indices for describing the thermospheric density response to Solar activity

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It is well known that the intensity of the geomagnetic activity observed at the surface of the Earth has a longitude modulation. This modulation has two major consequences: (i) a proper description of the geomagnetic activity at a planetary scale requires using quantities based upon data from stations evenly distributed in longitude, and (ii) planetary indices are worth being complemented by quantities monitoring the geomagnetic activity at a regional scale. The Kp network stations are located in Northern America, Western Europe and Australia/New Zealand, while the am network stations are evenly distributed in longitude for both hemisphere. am and ap variations may be very different during active geomagnetic periods. Furthermore, the dispersion of the longitude sector indices increases with magnetic activity. Using thermospheric densities deduced from STAR accelerometer measurements onboard the CHAMP satellite, we study the response of the thermospheric density to geomagnetic forcing in order to illustrate the impact of the choice of the geomagnetic index. We find that the correlation between the thermospheric density and geomagnetic activity is far better when using am indices. We also show how using longitude sector indices improve the thermospheric density description.

Keywords: thermosphere, solar forcing

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ASV039 **Oral Presentation** **3874**

Geomagnetic pulsations and ionospheric processes

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J. Verő

Period of FLR type pulsations depends not only on the length of the field line resonating due to UW waves, but also on the plasma density in the plasmasphere. Plasma density acts like a load, which affects parameters of the resonance circuit reducing period and amplitude. As plasma density in the plasmasphere originates from the ionosphere, first of all from the F-region, thus, values of the above mentioned parameters are influenced by the plasma (electron) density in the F-region. F-region electron density depends on intensity of ionizing radiation, but with increasing height more and more on β type (linear) recombination and ambipolar diffusion. Rate of β type recombination is a function of the ratio of the atomic oxygen concentration to the N2, O2 densities. Thus, period and amplitude of geomagnetic pulsations are also affected by the neutral composition. Polarization of FLR type geomagnetic pulsations depends on height integrated Hall and Pederson conductivities. Increase of polarization angle (counter-clockwise rotation) viewed from above is caused by enhanced height integrated Hall conductivity as compared with height integrated Pedersen conductivity.

Keywords: geomagneticpulsations

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ASV039 **Oral Presentation** **3875**

Forecasting storm-time changes in the ionosphere

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We present a coupled empirical model that allows us for the first time to forecast the F region critical frequency (foF2) with lead-times of 3 to 24 hours. We achieve this by computing a 3 hourly running ap index for those prediction horizons which is a measure of geomagnetic activity. The results are then fed that into the STORM model to account for the variations of foF2 in he ionosphere. A particular strength of the combined model is the ability to anticipate geomagnetic storms and changes in the F region ionosphere in response to that. We report on the initial validation findings and relevance of this model to the International Reference Ionosphere (IRI2000).

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ASV039 **Oral Presentation** **3876**

Statistical characteristics of the variability in the long-term geomagnetic records

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During the last century the geomagnetic activity exhibits a positive trend probably caused by solar periodicities with about 200-year or even more prolonged periods. The aa and AE indices at the beginning of 21th century has a higher average level than at the beginning of its calculation in 1868 and 1957, respectively. However, the amount of increase may result from the higher values or/and more frequent variations of the original values. These two kinds of behavior are controlled by different factors, specifically, by the strength and by the variability of the solar wind and electromagnetic radiations. In this study, we report the results of a statistical analysis of geomagnetic activity from the available long-term time series. Hour-to hour variability at different ranges of the activity is studied by using the AE index. We found the most significant upward trend in a frequent occurrence of the abrupt variations in AE at the range of 100-300 nT, an insignificant trend at 300-400 nT and no trend for stronger variations. The number of quiet hours (AE<100) gradually decreases. The trend in variability is seen in each month of the year except January and July. We extend the analysis to the last century by using the hourly data from two long-term high latitude stations. At both stations the local geomagnetic activity has increased during the last century. The trend is mainly determined by increased frequency of moderate activity in the manner similar to that inferred from AE. The statistical analysis applied to the global aa index reveals that during the period of observations the number of disturbed daysincreases whilethe number of quiet daysdecreases. The general intensity of disturbances is seemed to remain of the same value. We compare the long-term variation of time delay of the aa index relative to sunspot numbers with the long-term behavior of geomagnetic variability and discuss its possible connection to solar activity and geomagnetic field variations.

Keywords: geomagnetic, activity, variations

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ASV039 **Oral Presentation** **3877**

Validation/Reconstruction of the Sunspot Number Series, 1840-Present

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The 400-year long sunspot series is our primary direct record of space climate. Two series exist: the Zurich (now: International) series compiled by Wolf and successors, and the Group series by Hoyt and Schatten. The two series agree well back to ~1875, but before that the Group SSNs are systematically lower than the Wolf SSN. Wolf (and others) noticed that the amplitude, rD, of the daily variation of the Declination of the geomagnetic field varied with the sunspot number, R, and proposed a linear relationship: rD = a + bR. In fact, he used this relationship to calibrate the sunspot number for times before his own observations started (1849). Later researchers were less enthusiastic about this procedure. We re-examine Wolf's relationship using the range of the East component (rY). This range is directly related to the intensity of the ionospheric SR currents, which in turn depends on the conductivity of the ionosphere. Solar FUV radiation creates and maintains the ionosphere, therefore the rY range (corrected for the secular decrease of the Earth's main field) is a proxy of the FUV. We show that this proxy reproduces the F10.7 radio flux and the International sunspot number with a coefficient of determination of r^2 = 0.97, and recalibrate the sunspot number back to 1841 [geomagnetic data exists that may allow such recalibration back to the 1740s]. Cycles from ~1840 to 1900 have recalibrated peak numbers that are up to ~30%-50% larger than the currently used Group and/or Zurichnumbers.

Keywords: sunspot number, regular variation

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ASV039 **Oral Presentation** **3878**

Ground effects of space weather: use of geomagnetic data for analysis, real-time simulation and forecasting.

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The time-varying natural geomagnetic field produce electric currents (GIC) that affects all the conducting networks at the surface of the Earth. Among the most vulnerable ground-based technology are power transmission and pipeline infrastructure. Their proper functioning is vital, thus modelling, monitoring and forecasting of the impacts of space weather on these two subjects are important. We use geomagnetic data of different sampling rate such as 5-sec., 1min., hourly ranges local data and indices up to 3-hour global Kp index to analyse GIC recordings during different parts of geomagnetic disturbance, from sudden impulse to the whole period of storm. Another application is to use the local geomagnetic data and specific models of power grids and pipelines for real-time on-line services. The samples are the real-time GIC Simulator, developed for one of Canadian power utilities and Space Weather Service for Pipelines, developed for Canadian pipeline companies. We show that local geomagnetic indices are better than global indices for the representation of GIC levels. Hence, the forecast of local geomagnetic activity is needed. To provide this type of service, Regional Warning Centre includes in the forecast the results of the statistical studies of the geomagnetic activity across .

Keywords: geomagnetic, indices, data

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ASV039 **Oral Presentation** **3879**

Climatology of the geomagnetic activity

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We propose a classification of geomagnetic events based upon their empirical probability of occurrence during the last 50 years. As expected, the classification depends on the used geomagnetic index. It is illustrated using selected events. We also use the existing long series of geomagnetic and solar indices to describe the observed magnetic field behaviour in terms of conditional probability of magnetic activity given the solar activity. The solar activity is monitored using the sunspot number, and the magnetic activity using both indices and rapid variations (ssc). The obtained results are presented, and used to discuss the relevancy of parameters for magnetic activity climatology.

Keywords: geomegnetic activity, climatology

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ASV039 **Oral Presentation** **3880**

Evolution in the SC knowledge and its implications in terminology and classification.

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When continuous recording of magnetic variations were available, sometimes abrupt enhancements were observed at the beginning of episodes of magnetic activity. These events were first classified as a part of the disturbance and only remarked as the zero time in the storminess time. Only in later works, these impulses were studied separately and named as SSCs sudden commencement of a magnetic storm. The increasing interest in the study of these events could be traced in the former works which finally concentrated in the establishment of several committees by the IAGA to this aim and finally ended with the creation of the International Service of Rapid Magnetic Variations (SRMV) to whom the elaboration of official lists of events and promoting the knowledge of them was commissioned (Curto et. al, 2007). The availability of satellite data, specially those from solar wind whose sudden variations are considered now the origin of the SSC as well as comprehensive models which are able to explain their main morphological features could be considered capital in the clarification process of what is a SSC . SIs, regarded first as magnetic disturbances with different nature from SSC, has been proved to be caused by the same mechanisms and should be classified complementary to SSC. In this communication, we review the evolution of both, concept and operative detection of the SCs and we introduce the perspectives for future improvements. Finally, a proposition of terminology is done.

Keywords: sudden, storm, commencement

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ASV039 **Oral Presentation** **3881**

Contrubution of geometric parameters into geomagnetic activity in different models of the solar wind - magnetosphere interaction

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We present results of our study of dependence of geomagnetic activity (Kp and Dst indeces) from orientation of the solar wind velocity V, the Interplanetary Magnetic Field (IMF), electric field of the solar wind E with respect to geomagnetic moment vector M. Geometric parameters determining mutual orientation of each from these vectors and geomagnetic moment vector are calculated on the basis of measurements of solar wind velocity and interplanetary magnetic field at the Earth's orbit for the period 1963-2005 and computation of orientation of geomagnetic moment at solar ecliptic coordinate system (GSE) at the moments of measuring. We did not make any assumption concerning interaction mechanism when angles between the vectors were calculating, and selection of geoeffectness of each from them was carried out on basis of reaction of Kp and Dst to their changes. It follows from our study that in themselves changes of orientation of the interplanetary magnetic field with respect to the dayside geomagnetic field can explain about ~35% of observed variations of Kp. We detected clear increasing of Kp with increasing of value of the northward IMF (relative to vector M) and suggested our interpretation of this effect. The variation of orientation of vectors E and M explains 50% of Kp changes (and 75% Dst). It is established statistically that geomagnetic activity reaches disturbed level (Kp=6, Dst= -75 nT) by only change of the electric field component along the geomagnetic moment (without any southward component of the IMF along vector M, only northward component accompanies this increasing). Results demonstrate that variation of orientations of vectors V and M explains less than 15% of Kp variation. Based on our study we conclude that a reconnection mechanism based on determining role of value and direction of the solar wind electric field (geometric parameter is angle between vectors E and M) is the most effective compared with mechanisms of quasi-viscous interaction (angle between vectors of V and M) and of reconnection one based on main role of the southward IMF (angle between vectors of the IMF and M). Explanation of well-known annual variation of geomagnetic activity with peaks at near equinoxes is a good test for any mechanism of interaction. Based on our results about main role of changes of mutual orientation of the solar wind electric field and the geomagnetic moment in changes of geomagnetic activity we suggested a new explanation of annual and UT variation of geomagnetic activity. Phase of the statistical annual variation of geomagnetic activity is determined by annual variation of the geomagnetic moment component My at the plane perpendicular to the Sun-Earth line: maximal value at equinoxes and minimal value at solstices. Amplitude is modulated by the solar wind electric field component Ez perpendicular to the ecliptic plane.

Keywords: solar wind imf, magnetosphere, interaction

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ASV039 **Oral Presentation** **3882**

Forecasting magnetic storms using a novel wavelet analysis technique

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Magnetic storms are a central element of space weather: they have severe impacts on both space-borne and ground-based technological systems and therefore their prediction is a major goal of the space community. The most widely used statistical describer of magnetic storm activity is the Dst index. Balasis et al. (2006) applied a wavelet analysis technique to the Dst time series and showed that distinctive alterations in the scaling parameters of the index occur as an intense magnetic storm approaches. A similar spectral signature, i.e., transition from anti-persistent to persistent behavior prior to the storm, was not found for the main driver of the Dst index, the VBSouth electric field component. Therefore it was indicated that while the magnetosphere is mostly driven by the solar wind the critical feature of persistency in the magnetosphere is the result of a combination of solar wind and internal magnetospheric activity rather than interplanetary variations alone. Physical mechanisms originating in the magnetosphere and possibly related to the revealed behavior will be discussed.

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ASV039 **Oral Presentation** **3883**

Near real-time availability of the K based geomagnetic indices Kp, ap, Ap and Cp

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More and more scientific applications require global geomagnetic indices in near-realtime. Such indices, however, should be comparable to definitive indices, which are available on a long-term basis and are required for time series analyses and statistical purposes. The global geomagnetic indices Kp, ap, Ap and Cp extend back to January 1932. They are calculated in full accordance to the method introduced by Julius Bartels and approved by IAGA. This service is currently provided by Adolf-Schmidt-Observatory Niemegk of GeoForschungsZentrum Potsdam. The series of definitive indices is routinely updated twice a month on the web. Recently, we implemented a quick-look indices calculation in order to meet the requests of a near-realtime availability. The K numbers of the 13 Kp observatories are calculated on the basis of their minute values every 3 hours with a time delay of about 15 minutes. The Kp are calculated by means of the regular algorithm from these K numbers. The Kp, ap, Ap and Cp calculated this way are immediately provided on the web. The quick-look indices are replaced by the definitive numbers after their usual calculation every half month.

Keywords: quick look, geomagnetic, indices

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ASV039 **Oral Presentation** **3884**

Separation of atmospheric-ionospheric current signatures from magnetospheric current signatures during storm periods

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The reduction of ground-based magnetometer data to produce geomagnetic indices involves a number of specific sequential procedures to compensate for different physical processes. One of these procedures is designed to remove the ever present magnetic signatures that are associated with the currents in the ionosphere generated by the solar input into the upper atmosphere. Conventionally this is referred to as the "solar quiet" Sq correlation. The most basic form of which is that the three quietest days in a month are identified, these three days are used to generate the "Sq", and this is then subtracted from each day's magnetic record in the month. The result is a magnetic signature that reflects the effects of magnetospheric currents, which is not just the ring current signature.During storm periods, however, the upper atmosphere and ionosphere are no longer in the quiet state. Their temporal characteristics are also quite different from those of the magnetosphere. Hence, the removal of the Sq has made no allowance for the disturbance currents that are generated in the upper atmosphere-ionosphere. Prior studies of the Sq spatial distribution have found significant day-to-day variability in location and strength of the Sq system.Using Wavelet analysis technique we have developed techniques to study simultaneously multiple site geomagnetic records and the issues of: (a) characterizing the "Sq" in the Wavelet domain; (b) removing the "Sq" from the magnetic record; and (c) awareness of how this procedure is insufficient during storms have all raised non-trivial questions. The assumptions needed to be made in item (b) above are described and the consequences of doing so are discussed. Of specific interest is that a significant residual of "Sq" wavelet domain information is still present after the item (b) procedure is carried out during storms. These residuals are described in the context of disturbed atmosphere-ionosphere currents. Their relevance pertains to how this information can be used to monitor the state-of-the-upper atmosphere during storm periods.

Keywords: measurements, wavelets, indices

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ASV039 **Oral Presentation** **3885**

The global magnetometer network initiative: SuperMAG

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We present the global ground based magnetometer initiative: SuperMAG. Performing global studies utilizing ground magnetometer data from many different institutions has previously been complicated by the difficulty of obtaining data, the use of different coordinate systems, various inherent data errors, and finally different baseline techniques. The latter can prevent studies from being performed. In the SuperMAG initiative these issues are taken care of and the user can take full advantage of the unique temporal and spatial coverage provided by the ground based magnetometers. SuperMAG provide a much needed community data-service in which these obstacles are removed thereby enabling the investigator to focus on science rather than data processing. We present the philosophy behind the initiative, the solution to the practical issues and an overview of the data-products that will be provided.

Keywords: magnetometer, currents, global

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ASV039 **Oral Presentation** **3886**

A New Verifiable Measure of Centennial Geomagnetic Activity: Modifying the K Index Method for Hourly Data

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The K indices have long been the most important way to estimate geomagnetic activity. However, they have some basic and practical problems which restrict the reliability and applicability of these indices especially for long-term (centennial) studies. Here we discuss these problems, modify the K method and construct a new, straightforward, easily verifiable and homogeneous index, the so called Ah index, which is based on digital, hourly data and is dedicated for centennial studies. We study the centennial change in geomagnetic activity using the new indices at six long-term stations. At all six stations geomagnetic activity has increased during the last century. However, the amount of centennial increase varies greatly with latitude, being largest at high latitudes, smaller at low latitudes and, unexpectedly, smallest at mid-latitudes. While the centennial increase in the aa index is roughly twice larger than in the Ah index at mid-latitudes, comparison with the Ap index verifies that the scaling of the aa index was erroneously modified by a few nT in late 1950s. The Ah index correlates very well with the Ap index, better than the aa index and much better than the alternative, not-K based IHV index. Local Ah indices also include a similar diurnal variation of geomagnetic activity as local K/ak indices. While the local Ah indices can be used to extend the local K/ak indices, the global Ah index offers the most reliable extension of the Ap index by 30 years, and is recommended to use in centennial studies of geomagnetic activity instead of aa or IHV indices.

Keywords: geomagnetic indices

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ASV039 **Oral Presentation** **3887**

Earth's magnetic field behavior infered from wavelet analysis using a North-South array of magnetometers

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Coronal mass ejections (CME) are the primary cause of the highly disturbed conditions observed in the magnetosphere as measured by satellite or by ground based magnetic stations. Momentum and energy from the solar wind are transferred to the Earth's magnetosphere mainly via magnetic reconnection that creates open field lines connecting the Earth's magnetic field with the solar wind. This coupling results in magnetic activity within the Earth's magnetosphere. Statistical study of solar wind causes shows that sheath regions are the most important drivers of intense magnetic storms. The objective of this work is to infer some properties of the magnetospheric dynamics involved in the energy transport from auroral latitudes to the ring current by the different current systems that are involved in the interplanetary magnetic field – magnetosphere - ionosphere coupling. Magnetospheric currents are coupled to the ionosphere through field-aligned currents. This particular characteristic of the magnetosphere-ionosphere interconnection is responsible for the energy transfer from higher (auroral currents) to lower latitudes (ring current). In this work the fast and sharp fluctuations observed in the horizontal components of the Earth's magnetic field are examined using a set of magnetometers (TIK, KAK, GUA, KDU, CNB and DRV), approximately aligned around the geomagnetic longitude of 210o, from latitudes 70oN to 70oS. The events analyzed occurred on May 14-15, 1997, September 24-25, 1998 and October 18-19, 1998. The corresponding time series (magnetograms) were analyzed using wavelet technique. The great interest in wavelets today is due to their ability to efficiently represent functions with localized features. In the same way that the fast Fourier transform has made the Fourier transform a practical tool for spectral analysis, the multi-resolution analysis has made the Discrete Wavelet Transform a useful tool for computational time-scale analysis. The singularities observed in the wavelet signatures of the first three decomposition levels of the horizontal component of the Earth's magnetic field for the selected magnetic stations were submitted to a comprehensive analysis. The amplitudes of the wavelet coeffcients detected in the three first decomposition levels were compared. In the latitude range from ~ 40oS to ~ 60oN, the wavelet signatures do not show remarkable differences, except for the amplitudes of the wavelet coefficients. The sequence of transient field variations detected at auroral latitudes, probably associated with substorm occurrences, have their counter part at lower latitudes, where the effects of the ring current dominate. The time delay observed in the wavelet signatures of higher latitude stations in relations to the lower ones can give precious information on the main processes responsible for the energy transfer from auroral to equatorial latitudes.

Keywords: magnetospheric currents, wavelet analysis, energy transport

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ASV039 **Oral Presentation** **3888**

Geomagnetic indices in studies of Space Climate

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Geomagnetic indices form perhaps the most reliable and versatile method to study the long-term change in the Sun and heliosphere, i.e., the Space Climate. Indices of geomagnetic activity extend back in time until mid-19th century, covering more than 160 years. The Dst index has recently been extended to start in 1932, thus covering more than 70 years. Long-term geomagnetic activity depicts certain patterns and periodicities, the most dominant of which are the solar 11-year variation and the semiannual variation. Other significant fluctuations include the annual variation, 1.3-1.8-year variations and the 22-year variation. Moreover, the overall level of geomagnetic activity has increased during the last 100 years although the exact amount of increase is still debated. All of these variations reflect some fundamental properties of the Sun and the Sun-Earth connection. Although some of the above mentioned patterns and periodicities are known for a long time (e.g., the semiannual variation for nearly 150 years), the understanding of their connection with the Sun has been significantly improved recently. Here I will review the above mentioned properties in long-term geomagnetic activity and discuss the present understanding of their solar cause.

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ASV039 **Oral Presentation** **3889**

Revising the polar cap index definition: issues and choices

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The polar cap (PC) index has been calculated historically by using data from the Thule and Vostok ground magnetometers that are located near the northern and southern geomagnetic poles. The status of the PC index as an official IAGA index is under consideration pending a report that describes its method of production and that compiles any coefficients needed in the generation process. Such information is needed so that any researcher may independently calculate PC given raw Thule or Vostok magnetic field time series. There is also an effort to revise the PC index generation technique and to apply it to calculate both the northern and southern PC indices in a consistent fashion. This paper examines the issues such as secular variation and quiet day correction, determination of the preferred horizontal magnetic field perturbation direction, and calibration of the near-pole horizontal disturbance relative to the solar wind merging electric field that must be addressed so the update of the PC index generation scheme can be finalized

Keywords: polar cap, geomagnetic index, current systems

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ASV039 **Poster presentation** **3890**

The characteristic of morfology and structure of the class intensive geomagnetic disturbances

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Changes of solar activity mechanisms generate changes of the geomagnetic activity. Structure of geomagnetic activity could be presented by class periodical and aperiodical diurnal variations of geomagnetic field. It is the class Sq, Sd, DS, Dst and Di variations of the geomagnetic field. In 22nd and 23rd Sun's cycle (in period 1986-2006) in geomagnetic activity are registered several extremely intensive magnetic storms classes A. Those were the especially Big Magnetic Storms. First magnetic storm was registered in year of minimum Sun's activity, 06, February 1986. Second magnetic storm was registered in year of the maximum 22nd Sun's cycle Sun's activity, 13, March 1989. During secondary maximum of 23rd Sun's cycle, or in phase that is determined as phase post maximum of Sun's activity (PPM - Phase Post maximum), in autumn equinox, 29, October 2003, extremely strong and intensive magnetic storm is registered. At the first half of November 2004, intensive magnetic storm is registered. The rang of geomagnetic field variations, which are registered in isolated class of Big Magnetic Storms, was the ΔDst > 350 nT. In Big Magnetic Storms were registered maximum values of three-hour geomagnetic activity index K=9. In first phase of investigation, we have done statistical analyze of the regular daily geomagnetic field variations, in the month when is registered geomagnetic disturbance. In next step of analyze, in each of isolated magnetic storm, the groups of apperiodical and irregular geomagnetic field variations are observed. That is shown by the Dst and Di geomagnetic field variations. The Dst variations shows structure of the average hourly values of geomagnetic field, that are registered in the class Big Magnetic Storms. The spectrum Di variations is contended of the minute values of geomagnetic field, which are registered in the Big Magnetic Storms. By the Dst and Di geomagnetic field variations are presented individual/especial characteristic of class Big Magnetic Storm. In this paper will be presented structure of the spectrum Di variations which are registered during magnetic storm in March 1989, magnetic storm in October 2003 and magnetic storm in November 2004. Analyze of structure geomagnetic field variations, that are registered in the class Big Magnetic Storms, is done on several European observatories of the middle geomagnetic latitude (GCK, THY, AQU, EBR, CLF, BFE, NGK, WNG).

Keywords: magnetic storms, geomagnetic field variations, solar activity

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ASV039 **Poster presentation** **3891**

Relevant activity indicators of geomagnetically induced currents

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Geomagnetically induced currents (GIC) flowing in technological ground-based conductor systems such as power grids can cause various problems from minor nuisance to system blackouts. The probability of GIC is largest during high geomagnetic activity, as defined by conventional magnetic indices (K, Ak, aa, ...). However, standard indices are based on the variation ranges of the magnetic field in periods of some hours or longer, and they may suffer from saturation during the most extreme events. In turn, GIC is primarily related to the time derivative of the magnetic field (dB/dt), which varies rapidly within timescales of a couple of minutes. Based on direct GIC measurements in the Finnish natural gas pipeline, we demonstrate the strengths and weaknesses of traditional indices as well as discuss a couple of alternative activity indicators.

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ASV039 **Poster presentation** **3892**

Kp forecast models

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Magnetically active times, e.g., Kp > 5, are notoriously difficult to predict, precisely when the predictions are crucial to the space weather users. Taking advantage of the routinely available solar wind measurements at Langrangian point (L1) and nowcast Kps, Kp forecast models based on neural networks were developed with the focus on improving the forecast for active times. In order to satisfy different needs and operational constraints, three models were developed: (1) model that inputs nowcast Kp, solar wind parameters, and predict Kp 1 hr ahead; (2) model with the same input as (1) and predict Kp 4 hr ahead; and (3) model that inputs only solar wind parameters and predict Kp 1 hr ahead (the exact prediction lead time depends on the solar wind speed and the location of the solar wind monitor). Extensive evaluations of these models and other major operational Kp forecast models show that while the new models can predict Kps more accurately for all activities, the most dramatic improvements occur for moderate and active times. The evaluations of the models over 2 solar cycles, 1975-2001, show that solar wind driven models predict Kp more accurately during solar maximum than solar minimum. This result, as well as information dynamics analysis of Kp, suggests that geospace is more dominated by internal dynamics during solar minimum than solar maximum, when it is more directly driven by external inputs, namely solar wind and IMF.

Keywords: kp, forecast, models

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ASV039 **Poster presentation** **3893**

Geomagnetic Effects of a Solar Flare during Halloween Superstorm

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Mauro Regi

One of the immediate consequences of the interaction between the flare emitted electromagnetic radiation with the Earths upper atmosphere is the geomagnetic solar flare effect (SFE) which typically manifests as a sudden, short-lived perturbation in the geomagnetic field elements, mostly at equatorial and low latitudes in the sunlit hemisphere. Halloween superstorms were anticipated by a remarkable SFE manifestation (Oct., 28, 2003) which was clearly detected at several geomagnetic arrays. 1 min measurements of the geomagnetic field elements at those stations allow to investigate the longitudinal and latitudinal extension of the field perturbation, inferring the gross scale characteristics of the ionospheric current system.

Keywords: sfe, crochet

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ASV039 **Poster presentation** **3894**

Ap-index as a function of solar wind input and its seasonal variations

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M. Zakharov

Seasonal periodicity of geomagnetic activity and Ap-index in particular is a well known phenomenon, addressed in many publications. Suggested sources of it are: axial hypothesis (heliospheric factor), Russell-McPherron effect (GSE-GSM IMF transformation) and equinoctical hypothesis (magnetospheric/ionospheric response factor). Previous analyses were based on index data only, not including solar wind observations. In our investigation we express Ap-index as a function of solar wind and IMF and determine that seasonal variations in Ap-index on average (1963-2000) consists of 56% of magnetospheric/ionospheric response, 29% of heliospheric factor, 7% of R-M effect and 8% is due to non-linear terms. In particular, it was found, that while autumn/spring magnetospheric response functions are almost identical, there is substantial difference between winter and summer functions.

Keywords: s

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ASV039 **Poster presentation** **3895**

Medium- and long-term perodicities in geomagnetic parameters

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Marisa Storini

Available data series of geomagnetic indices (aa, Ap, Kp, Dst, PC and AE) were considered to search for periodicities in geomagnetic activity. The Fast Fourier Transform and Wavelet techniques were used to determine the reliability of each medium- and long-term identified period. Particular attention is paid to effects induced by the solar synodic rotation period through the solar wind-magnetospheric coupling. Moreover, the 27-day periodicity is analyzed along the solar cycle evolution to better understand its role inside the Space Climate issue.

Keywords: geomagnetic indices, wavelet, periodicity

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ASV039 **Poster presentation** **3896**

Comparing SARGENT III and LEVITIN ET AL. methods to identify time intervals characterized by recurrent solar wind structures

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Sargent III [JGR 90 (A2), 1425-1428, 1985] introduced a simple index to describe the recurrent geomagnetic activity induced by corotanting long-lived solar wind streams during the solar cycle. The method was developed by using the aa index [Mayaud, IAGA Bull. 33, 1973] and starting by performing correlations between data of two consecutive Bartels rotations. Ten years later, Levitin et al. [Geomagn. Aeron. 30 (2), 260-263, 1995], published an index based on correlations of aa data for a 27-day interval and the two preceding intervals. We tested both methods for different geomagnetic indices and extended the computations up to six Bartels rotations. Results are used to discuss the reliability of the inferred long-lived solar wind structures at the Earth position.

Keywords: bartels, periodicity, geomagnetic indices

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ASV039 **Poster presentation** **3897**

A Floor in the Solar Wind Magnetic Field

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Long-term reconstructions of the interplanetary magnetic field (IMF) based ongeomagnetic indices and the sunspot number indicate that the solar wind magnetic fieldstrength has a floor, a baseline value in annual averages that it approaches at each 11-yr solar minimum. At 1 AU in the ecliptic plane the IMF floor is ~4.6 nT. This corresponds to a nominal radial field component of ~3.3 nT, matching that observed by Ulysses for a broad range of polar latitudes, and significantly different polar field strengths, during solar minimum conditions in ~1995 and 2006 (as well as during solar maximum conditions in ~2001). We identify the floor with a constant (over centuries) open solar magnetic flux at 1 AU of 4.6 x 10(**14) Wb. Solar cycle variations of the IMFstrength ride on top of the floor. The floor has implications for: (1) the solar wind during grand minima we are given a glimpse of Maunder Minimum conditions at every 11-yr minimum when the sunspot number approaches zero; (2) models of the coronal magnetic field and solar wind current models cannot reproduce the Ulysses observations, polar fields do not determine the magnitude of high-latitude IMF; and (3) the use of geomagnetic input data for precursor-type predictions of the coming sunspot maximum this common practice is rendered doubtful by the observed disconnect between solar polar and heliospheric field strength.

Keywords: solar wind, interplanetary magnetic field

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ASV039 **Poster presentation** **3898**

Determination of the quiet daily geomagnetic variation in on-line regime.

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A new automatic method for derivation of the quest daily geomagnetic variation - "quiet day curve" (QDC) is described. The method consists in the automatic distinction of the quietest periods using the geomagnetic variations parameterization, calculation of the proper quiet daily variation for certain days, restoration of QDC for each day of the elapsed period, and extrapolation of QDC for the subsequent period. The method ensures reliable QDCs during the epoch of the solar activity maximum if the time interval used for derivation of QDC is not less than 30 days. The method of the running QDC calculation implies uninterrupted calculation of the QDC resulting from the continuous 1-day forward shift of the 30-day interval. The running QDC method makes it possible to derive the quiet daily variation automatically; which is the main advantage over other known methods. It is shown that along with the seasonal (from month to month) and the solar cycle (from year to year) changes, the QDC amplitude is modified on a time scale lasting a month following solar activity flashes.

Keywords: qdc, magnetic, on line

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ASV039 **Poster presentation** **3899**

New substorm index derived from high-resolution geomagnetic field data at low latitude and its comparison with real-time AE index

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Toshihiko Iyemori, Masahiko Takeda, Takashi Ookawa, Gerardo Cifuentes-Nava, Jrgen Matzka, Mustafa K. Tuner

Geomagnetic field data with high time resolution (i.e., 1 second) become more popular recently. Using such high time resolution data, we can identify Pi2 pulsations which have a period of 40-150 s and an irregular waveform. It is generally accepted that Pi2 pulsations appear clearly in mid- or low-latitude ground station on the nightside in close connection with substorm onsets. Thus we can monitor substorm activity at any given time if we examine Pi2 activity at multiple geomagnetic observatories which distribute globally with longitudinal separation of ~120 or less. Here we propose a new index reflecting Pi2 wave power at low- and mid-latitude. This index is derived by wavelet analysis for geomagnetic field data obtained at three different longitudinal sectors, that is, the Asia,Europe, and North/Middle America sectors. Possible observatories are Kakioka, Teoloyucan, Iznik, and Frstenfeldbruck. We will make a comparison of substorm activity estimated from this new index and that from the AE index.

Keywords: substorm, pi2 pulsation

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ASV039 **Poster presentation** **3900**

A Guide for Geomagnetic Indices Derived from Earth Surface Data

Prof. Michel Menvielle
IAGA

Heather Mccreadie

This guide aims to provide practical information for users of geomagnetic indices.It targets those who are not experts in the field and provides useful information for those wishing to improve their knowledge. The guide is split into two sections; user oriented, and 'scientific aspects, which can be read separately or as a whole. The user oriented section provides suggestions as to which geomagnetic index is appropriate for various situations. It also provides brief descriptions of what each index is, how it is derived, the time resolution, applications and availability. The scientific aspects section contains extended descriptions, including the scientific explanations as to why the index was established.

Keywords: iaga guide for indices

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ASV039 **Poster presentation** **3901**

The ISGI www homepage

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Alain Pan

The ISGI Publication Office WWW homepage: http://www.cetp.ipsl.fr/~isgi/homepag1.htm aims at providing simple and efficient access to geomagnetic indices, either directly or through mirror links to the WWW sites of the ISGI Collaborating Institutes (GFZ Potsdam, Germany; WDC-C2 for Geomagnetism, Kyoto, Japan; Observatori de l'Ebre, Roquetes, Spain). It is worth noting that the indices data series provided trough the ISGI www homepage are directly got from the ISGI corresponding institute in charge of the index derivation.The information and data series available at the ISGI WWW homepage are:(i) information on ISGI;- (ii) reference papers on indices derivation and availability; (iii)provisional and definitive values of AU, AE, AL, aa (Kpa, aa in Kp units), am (Kpm, am in Kp units), Kp, and Dst indices as monthly tables or ASCII files (hourly values for AU, AE, AL, and Dst; 3-hour values for the K-derived indices); (iv)definitive list of ssc; (v) provisional, and definitive values of K-derived longitude sector activity indices; (vi)quick-look values of aa (Kpa) 30 minutes after the end of the time interval, and am (Kpm) indices at day D+2; (vii)musical diagrams (as post files) for aa and am indices; (viii)ISGI Monthly Bulletins for the current year and the two previous ones; (ix)selected papers; (x)sources of softwares for computer derivation of K indices.

Keywords: on line data dissemination

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ASV039 **Poster presentation** **3902**

Quick-look, provisional and definitive vakues of am and aa indices

Prof. Michel Menvielle
IAGA

Quick-look values of am and aa indices are routinely calculated and made available on a daily basis by the ISGI Publication Office, since the end of 1996. Since June 2004, quick-look values of aa indices are now routinely calculated on a 3-hour basis, and made available 30 minutes after the end of the 3-hour interval. Quick-look values are computed using K indices computed (FMI algorithm) from minute values automatically got from the observatories. The computation is made on an available data basis, when K indices from enough observatories are available. Provisional values are computed on an available data basis, using K values provided by the stations. These values aim at providing estimates of the definitive values of the indices: am provisional values are computed and circulated within about 6 weeks after the end of the month; aa provisional values are circulated within a one week delay, thanks to the Solar Influences Data analysis Centre (SIDC) at the Royal observatory of Belgium (Brussels). aa definitive values are circulated within about 6 weeks after the end of the month. The up-to-date analysis of am quick-look, provisional, and definitive values is presented and discussed.

Keywords: qiuck look values, on line dissemination

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ASV039 **Poster presentation** **3903**

New Magnetometer in Southern Sweden at LOIS, Lund

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A fluxgate magnetometer is being installed at the LOIS Space Centre radio infrastructure test station in Risinge outside Vxj in Southern Sweden. The magnetometer data will be available from Regional Warning Center Sweden of International Space Environment Service at Swedish Institute of Sweden in Lund. Data will primarily be used for real-time predictions of geomagnetically induced currents (GICs), based on solar wind data from ACE and neural network models.

Keywords: space weather, magnetometer, rwc sweden lois

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ASV039 **Poster presentation** **3904**

Using of the geomagnetic indices for the study of probability appearance of the equatorial scintillations during geomagnetic storms

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In this study the solar wind and the equatorial ionosphere parameters, Kp, Dst, AE, AU and AL indices characterized contribution of different magnetospheric and ionospheric currents to the H-component of geomagnetic field are examined to test the space weather effect on the generation of ionospheric irregularities producing VLF scintillations. The equatorial and the polar ionosphere of the Earth produce serious problems in communication and navigation systems during the different kinds of geomagnetic disturbances. The solar wind and geomagnetic storms cause a wide spectrum of irregularities and processes which are generated from the polar ionosphere to the equatorial ionosphere. However, the space weather effects the on the equatorial ionospheric phenomena are not studied completely and the physical nature of many penetration mechanisms from the Polar Regions to the equatorial ionosphere has not been completely understood. We demonstrate relationships between the equatorial ionospheric scintillation and the IMF Bz, Dst, Kp, AE, AL. It is shown that all these indices and the Bz of the IMF are suitable for investigations of scintillation activity at the equatorial ionosphere. Although it is assumed that the Dst index is convenient and available for the geomagnetic conditions studies during the ionospheric scintillations, the examples show that difficulties emerge when we consider relation of the magnetospheric ring current to the equatorial ionosphere height variations and scintillation activity. The reason is that the Dst index not includes the auroral sources. Kp activity take better advantage to depict of scintillation activity because it as planetary index carries more information about auroral electrojets. We show that the auroral indices AE, AL and Kp do better than Dst index for the prediction of the ionospheric scintillation at the equator. It is found that the factor, which presents during magnetic storms to fully inhibit scintillation, is the positive Bz-component of the IMF. It is found that during the positive Bz IMF F layer cannot raise altitude where scintillations are formed. The space weather effect on the auroral ionosphere and models can explain the relationship between the equatorial ionospheric parameters as h'F and foF2, and the equatorial geomagnetic variations with the polar ionosphere currents and the solar wind. Taking into account the time delay between the solar wind and the ionosphere phenomena, the relationship between the solar wind and the ionosphere parameters can be used for predicting of scintillation activity.

Keywords: geomagnetic indices, scintillation, ionosphere

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ASV039 **Poster presentation** **3905**

The Combined Polar Cap (PCC) Index as a Space Weather Parameter

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The now unified polar cap indices, PCN for the northern polar cap and PCS for the southern polar cap, are derived from analysis of magnetic variations in the polar caps (Troshichev et al., 2006). The indices mainly relate to the transpolar ionospheric electric currents generated by the interaction of the solar wind with the magnetosphere. The presentation discusses the relations between the PCN and PCS indices and the interplanetary merging electric field (MEF) with particular emphasis on the correlation of a combined PC index, PCC, with the MEF. The MEF parameter closely correlates with global disturbances such as magnetic storms that are caused by the impact on the magnetosphere of the enhanced solar wind following eruptive solar activity. The new PCC index resolves the ambiguity implied in having two index series to be proxy for the same merging electric field and it represents global magnetic activity better and more reliable than the individual PCN and PCS indices. The presentation provides examples of the close relationship between the new polar cap index and the growth of global magnetic activity level represented by the Dst index. The PCC index can be used in analyzes of magnetically disturbed conditions and to provide forecast of geomagnetic storm level during the initial phase.

Keywords: polar cap index, space weather, geomagnetic storm

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ASV039 **Poster presentation** **3906**

The Geomagnetic Digital Data of Trelew and Las Acacias Observatories and Their Relationship With Space Weather Effects

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Nicols Maciel Quaglino, Ricardo Ezequiel Garca

The Geomagnetic Observatories of Trelew (Lat.:-43.3; Long.:294.7) and Las Acacias (Lat.:-35.0; Long.: 302.3) have digital records, the former since 1993 year to the present time and the second since 2000 year to the present. In this work, the effects caused by a Coronal Mass Ejection (CME) and fast solar wind event and solar streams during the last solar cycle, are presented. Geomagnetic storms are selected and then compared with the records obtained in others observatories from the region, such as San Juan de Puerto Rico (SJG), Vassouras (VSS), Huancayo (HUA), Hermanus (HER) and Vernadsky (AIA). Their geographical ubication is also important as a mean of monitoring the induction effects in the ground-based technological estructures. It is conclude that the use of digital records by means of protonic precesion magnetometers is useful in the correlation of CME effects and in the analysis of the registered storms effects on pipelines induction.

Keywords: space weather, observatories, digital data

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ASV039 **Poster presentation** **3907**

Local Vector Activity Proxy Indices: using INTERMAGNET observatories to estimate local magnetic field conditions

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The INTERMAGNET network of geomagnetic observatories provides high-quality one-minute data from over 100 observatories around the globe. This distribution of ground observatories is potentially a useful resource to determine new activity proxy indices for different scientific and other purposes. As an example we describe how, for a given position and time, an AE proxy index value can be determined for any geomagnetic field component, using data from the three closest available observatories to the sample point, and giving a local measure of the magnetic field activity level. We examine whether there is merit in using this local estimate of the external field activity, as opposed to the standard large-scale indices. We consider if further refinements of the technique, for example by interpolation of local observatory data, can enhance the results obtained. Currently standard global indices are used in data selection procedures (to reject geomagnetically active satellite data) when modelling the internal magnetic field. Active periods are regarded as noise for this purpose, as the external field can mask the signal from the internal field. The technique described here may help in such data selection. It may also have other applications, for example to help determine the magnetic field variation in areas poorly covered by geomagnetic observatories or where an observatory 3-hour K measure of local variations does not give enough time resolution.

Keywords: geomagnetic activity, geomagnetic indices, geomagnetic observatories

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ASV039 **Poster presentation** **3908**

Is there a need to revise the aa index?

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Mark Clilverd

The three-hourly aa index provides one of the longest continuous global geophysical data sets that can be used in the analysis of magnetospheric and ionospheric phenomena. It was retrospectively calculated from 1868 (Mayaud, 1972) and it is defined as the average of the equivalent amplitude K indices (nT) from two near-antipodal magnetic observatories. Studies on long term changes in geomagnetic activity have identified possible small step-like baseline changes (<3nT) at various times throughout the data set. Although these do not affect conclusions reported on the overall upward trend of geomagnetic activity over the last century, they may be important for any accurate quantitative analyses. Although very small, the baseline steps have resulted in doubt from some researchers over the usefulness of the data set for long-term studies. This paper therefore reviews the existing work and investigates further the occurrences and possible causes of the step-like changes. In particular, we investigate separately the northern and southern hemisphere components of the index. We address the question as to whether there is a need for an official IAGA revision of the index and we discuss possible correction methods. Reference Mayaud, P. N., The aa indices: 1972., A 100-year series characterizing the magnetic activity, J. Geophys. Res., 77, 6870 6874

Keywords: geomagnetic activity indices, aa index, geomagnetic observatories

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ASV039 **Poster presentation** **3909**

Corrected hourly values from Eskdalemuir observatory and the implications for studies on the long term changes in geomagnetic activity

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The UK observatory hourly values published in yearbooks were digitised in the 1970s and made available for research purposes. It has recently been discovered by Martini and Mursula (2006) that the available Eskdalemuir data for the years 1911 to 1931 are 2-hour running averages instead of the original hourly values published in the yearbooks. The reason for this is likely to have been to maintain consistency with the data from 1932 onwards, which are hourly mean values centred at 30 minutes past the hour. Originally, these data sets were primarily used for studies into the main geomagnetic field and its secular variation, where the absolute level of the data and changes of the order of years to decades are the most important factors, rather than the variations from hour to hour. More recently, variations in the hourly values from long running observatories, like Eskdalemuir, have been identified as important for studies on the long-term changes in geomagnetic activity and the consequences of these for climatological models of electrical current systems in the magnetosphere and ionosphere. Data sets of this type have also been used to derive proxies for solar irradiance for use in studies of the natural component of climate change. This paper describes the process carried out to re-digitise the hourly values from the yearbooks for 1911 to 1931, made necessary owing to the loss of the earlier digitised data. We also present the results from a study by Macmillan and Droujinina (2007) on the long-term change in the regular quiet diurnal variation (Sq). Using the hourly values from Eskdalemuir and those of 13 other mid-latitude magnetic observatories, estimated amplitudes of Sq are computed and we show that the variations in these are well correlated with solar irradiance in the EUV band, as depicted by the F10.7 and E10.7 indices. The effect of the correction to the Eskdalemuir data set on these results and on the results of other studies using Eskdalemuir hourly values to depict the long term changes, such as those using the inter-hour variability (IHV) index, are discussed. References Martini, D. and Mursula, K., 2006., Correcting the geomagnetic IHV index of the Eskdalemuir observatory, Ann. Geophys., 24, 34113419 Macmillan, S. and Droujinina, A. 2007., Long-term trends in geomagnetic daily variation, Earth Planets Space (accepted 2007)

Keywords: hourly values, geomagnetic observatory, quiet diurnal variation

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ASV039 **Poster presentation** **3910**

How wavelet singularities can be used to characterize geomagnetic storms

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Magnetic storms are recognized as a worldwide decrease of the horizontal component of the Earth's magnetic field measured at its surface by magnetometers. Magnetic storms related to CMEs are storms caused by ejecta, sheath region and post- shock streams. The response of the magnetosphere to interplanetary shocks and pressure enhancements is global and almost immediate. Sheath regions are likely to induce intense activity at high-latitudes and rapid changes in ionospheric currents and electric fields. Practically all interplanetary shocks observed can be associated with CMEs with satisfactory confidence. During the main phase of the magnetic storm the contributions of the symmetric component of the ring current, the tail current, and the magnetopause current are comparable, although the effect of the last two current systems, roughly compensate one another. The purpose of this work is to identify the behavior of magnetic storms of different intensities. From 198 magnetic storms recorded at Kakioka magnetic station with one minute time resolution that occurred from January 1997 to December 2004, 53 (25 moderate, 14 intense and 14 superintense) have been analyzed independently of being single events or not. The wavelet technique was chosen to investigate such geomagnetic storms due to the ability to analyze non–stationary signals. Wavelet transforms are good tools to "zoom in" on short-lived high-frequency phenomena, such as singularities in signal and transient structures. We used the wavelet coefficients signature of the first three decomposition levels in order to characterize the storm taking into account the amount of energy transfered as transients, during the main phase of the storm. Starting from KAK magnetometers, a wavelet signature was obtained for each event. A hard thresholding process was applied to the first three decomposition levels and the wavelet coefficients above the threshold were counted. The energy accumulated in these peaks was then integrated and a well established positive correlation between Dst and the number of peaks and acumulated energy allowed a straightforward identification of the storm intensity. The determination of a general trend and the characteristics of the magnetospheric activity generated by different solar-wind drivers can be seen as a step forward in understanding the complex issue of the magnetospheric dynamics. Smooth variations, as the main envelope of the magnetic storm, are not detected by the wavelet analysis within the scales used. Solely the quick and sudden discontinuities are highlighted in this analysis.The big amplitude of the wavelet coefficients in the shock–like regions are associated with the sharpness of the transient phenomena. These transients are produced by the simultaneous effects of different current systems, which main contribution is attributed to the ring current. The main result of this work is that it presents an alternative method to locally infer the intensity of a magnetic storm based uniquely on one magnetometer data (Kakioka).The authors believe that potentially, this tool would be of great help in a comprehensive characterization of the intrinsic processes that characterize a magnetic storm.

Keywords: geomagnetic storms, wavelet analysis, dst index

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ASV039 **Poster presentation** **3911**

Dcx an extended and corrected Dst index

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Despite its great success as one of the most useful geomagnetic indices, the Dst index is known to include some errors, i.e., an excessive, seasonally varying quiet-time level, the so called "non-storm component" which is unrelated to the intensity of the ring current or magnetic storms. We have recently calculated a corrected and extended version of the Dst index, the so called Dcx index for 1932-2005. Here we review the problems in the Dst index and the rationale for introducing the Dcx index. We discuss the properties of the Dcx index and compare them with those of the Dst index. E.g., as a demonstration of the significance of corrections, even the yearly averages of the Dcx index correlate considerably better with sunspots numbers and indices of geomagnetic activity than the Dst index. We also discuss the long-term results obtained by extending the index to earlier times, starting from the second Polar Year in 1932.

Keywords: dst index

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ASV039 **Poster presentation** **3912**

Transient effetcs detected during magnetic storms and solar-proton events in the South Atlantic magnetic anomaly Region

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Because of its peculiarities, the South Atlantic Magnetic Anomaly (SAMA) has been pointed as the main cause of failure or misfunctioning of satellites, spacecrafts and space stations orbiting the Earth at altitudes from 300 to 1000 km. Different types of damage have been related such as severe radiation exposure of manned expeditions, frequent circuitry damage and communication interruptions in satellites. Because of the weak magnetic field observed in the SAMA, this region is seen as a natural sink for the energetic particles trapped in the inner van Allen radiation belt. On the other hand, the behavior of the horizontal component of the Earth's magnetic field (H) during magnetically disturbed periods has already been well characterized in a previous analysis using wavelet technique to identify the "shocks" that are often observed in the main phase of the magnetic storms. In this work, one minute resolution magnetograms recorded at the Brazilian stations Vassouras (22.40S; 46.35W) and So Martinho da Serra (29.44S; 53.82 W), which are under the influence of the SAMA were analyzed using a Daubechies wavelet transform family. The geomagnetically disturbed period 5-26 August, 2003 has been selected since a moderate (- 67 nT) and an intense (- 168 nT) magnetic storm occurred respectively on August, 06 and 18. The characteristics of the magnetic signatures obtained in the SAMA were compared to those measured at Kakioka (Japan) where the total strength of the Earth's magnetic field is quite different from the SAMA. The great amount of wavelet coefficients observed in the stations under the SAMA seems to show that much more energy has been stored there than over Japan, as it was expected as a consequence of the oddity of the Earth's magnetic field in that region. Ionospheric measurements of cosmic noise absorption in the SAMA region, together with interplanetary medium parameters and on ground magnetometer data were used to examine how the effetcs of solar energetic particles can affect the space and time configuration of the ring current, during the geomagnetically disturbed period 25 August – September 2, 1998. The time series have been also been analyzed using wavelet techniques, particularly devoted to the detection os singularities, which emphasizes the transient behavior of each signal. The amplitude and number of coefficients have been analyzed and the results discussed in terms of time delays and periodicities in the wavelet signatures of the data. An attempt is made to interpret the likely processes that can be responsible for the variations measured in the ring current and the role of the energetic particles fluences in the in ionizing the lower ionosphere, mostly in the SAMA. With this analysis, the authors intend to contribute and encourage new efforts to improve the insipient knowledge on the peculiarities of the SAMA during magnetic storms, taking advantage form the fact that the Brazilian territory is almost completely under the influence of this natural laboratory.

Keywords: solar energetic particles, south atlantic anomaly, wavelet analysis

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ASV040 **3913 - 3920**

Symposium
Division V Reporter Reviews

Convener : Prof. Toshihiko Iyemori

This session is composed of invited papers which review important progress or discovery in observation, modeling and interpretation of geomagnetic field. All Division-V research topics are covered, from geomagnetic data acquisition systems, magnetic observation (ground/satellite measurements and survey programs), field modeling, geomagnetic indices, data dissemination, and analyses, in the context of a new understanding of the geomagnetic field.

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ASV040 **Oral Presentation** **3913**

Review of historical field modelling and patterns of secular variation

Dr. Chris Finlay
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This talk will review recent progress in modelling Earth's magnetic field on timescales from decades to centuries, patterns of secular variation found in historical models and how these might be interpreted in terms of core processes. The current state of historical field modelling including the data sources used and inversion procedures employed will be discussed. Efforts to construct a new historical field model including constraints from archaeomagnetism, an improved treatment of repreat station data, observatory annual means to 2005 and satellite data will be described. The complementary nature of archaoemagnetic and historical field models will be reviewed. Patterns of field evolution at the core surface including the westward drift of wave-like patterns at low latitudes in the Atlantic hemisphere, the decay of the dipole field and growth of reversed flux features will be discussed. Possible interpretations involving core flows, hydromagnetic waves and magnetic diffusion will be reviewed and the new insights being given by dynamo models will be described.

Keywords: historical, sv, core dynamics

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ASV040 **Oral Presentation** **3914**

Progresses and challenges in magnetic observatory operation

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The des cription of the recent progresses in ground based magnetic observatory operation encompasses several aspects: instrumentation, acquisition, accuracy estimation, data processing, data transmission, opening of new observatories. In the present state of the art, manual absolute measurements remain the most accurate way of controlling the base lines of the magnetometers, whatever their type. Their obvious drawback is that the observatories have to be operated by a trained observer. This condition may be difficult to fulfil in remote areas. In addition, economic pressure may result in a reduction of the observer staffs. Efforts are made for several years towards more automatization of the absolute measurements. Two recently proposed solutions (Rasson and Van Loo, one one hand, Auster et al. on the other hand) will be discussed. Both solutions, however, still need the presence of an observer. The most elegant way of solving the problem would be to imagine continuous recording absolute magnetometers. An idea, originally proposed by Alldredge (1960) led to the development of the DIDD instrument (Hegymegi, Krmendi). Although many improvements were brought to the successive versions, it still requires manual base line controls. In addition, the instrumental reference frame is not easy to determine. More recently, a new concept was implemented, based upon the modulation of the signal of an optical pumping magnetometer by two orthogonal coils (Gavrand et al.,2001). Although it should be more stable than the DIDD system, similar problems arise with the orientation of the instrument. Numerical acquisition, based upon some kind of data logger, is now the standard, the typical reference being the Intermagnet network. Currently, concerns focus on resolution, sampling rate and time stamp. These issues become particularly crucial with the solicitation for moving towards sub-minute - typically one second- sampling rates. Worldwide synchronized one second data (in addition properly filtered) acquisition and dissemination will probably be a big challenge for the next future. Even data processing and accuracy estimation for the current one minute sampling rate have not yet reached their mature estate. Efforts have still to be made towards a more homogeneous processing protocol and accuracy estimation based upon safe statistical methods. The last issue includes sensor orientation and calibration aspects. Various calibration methods are regularly suggested but the sensor orientation problem is probably underestimated. Finally, we will evoke the efforts made towards a more homogeneous worldwide distribution of ground-based observatories with a particular emphasis on observatories opened or planned in remote areas. However, it is obvious that due to the poor distribution of emerged lands, this endeavor will remain limited. Extending the netword to ocean bottom observatories could be an exciting challenge for the next future, although technically difficult and financially demanding.

Keywords: magnetic, observatories, progresses

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ASV040 **Oral Presentation** **3915**

Mass density remote sensing using ULF pulsations detected by magnetometers

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Magnetic field variations in the period range of 1-1000 s are permanently present in the magnetosphere and they are known as ULF pulsations. The pulsations very often contain regular oscillations that arise from standing MHD waves and these pulsations provide valuable information on the mass distribution in the magnetosphere. Consequently, a large number of ground magnetometers have been deployed to detect the pulsation signal in an effort to capture the global mass distribution. The successful mass density estimation based on ULF pulsations requires precise determination of the standing wave frequency and realistic modeling of the background magnetic field and the distribution of mass along the magnetic field lines. This presentation reviews the recent progress regarding these technical requirements and the modeling results with emphasis on the magnetospheric mass distribution during geomagnetic storms.

Keywords: magnetometer, remotesensing, pulsations

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ASV040 **Oral Presentation** **3916**

Recent progress in mapping and modeling the magnetic field generated in the Earth's lithosphere

Dr. Vincent Lesur
IAGA

Due to the Champ satellite low altitude orbits, the satellite data acquired over the last few years have been particularly well suited for modeling the magnetic field generated in the Earth's upper lithosphere. Parallel to this increase in data availability and quality, several new modeling techniques have been published resulting in significant improvements in magnetic crustal field models. The available models as well as the processing techniques used to produced them will be compared. Localized representations of the magnetic field are likely to be the way forward in order to build more robust and accurate models. Examples will be given on how these techniques have been implemented. It is likely that with the launch of the ESA multi-satellite SWARM mission, we will be able to improve again the magnetic field models and bridge the spectral gap between survey satellite data and aeromagnetic data. This will result in a clear improvement in our understanding of the magnetic field generated in the lithosphere with direct consequence on projects such as the World Digital Magnetic Anomaly Maps.

Keywords: geomagnetic field, lithospheric field

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ASV040 **Oral Presentation** **3917**

The role of INTERMAGNET in serving the magnetic observatory and wider scientific communities

Dr. David Kerridge
Executive Committee Past President IAGA

The INTERMAGNET programme began as an initiative to modernise the operations of magnetic observatories and to make advances in the ability to exchange geomagnetic field data promptly. It has since evolved into an informal federation of many of the worldwide agencies responsible for magnetic observatory operations. In 2007, nineteen years after the INTERMAGNET programme started, with the formation of management and technical committees, over 100 magnetic observatories, more than half of the total number of observatories in operation worldwide, are participating. It should be remembered that INTERMAGNET does not run magnetic observatories itself; individual agencies do. However, INTERMAGNET plays a co-ordinating role helping to ensure that the global network, composed of individual observatories, acts as an Earth monitoring system. INTERMAGNET serves the observatory community by making concrete recommendations on observatory instrumentation and observing practice, by defining standards for data measurement, capture, processing and transmission, and by specifying formats for data transmission, storage and exchange. INTERMAGNET also offers advice and assistance to individual observatory operators. INTERMAGNET serves the international scientific research community by facilitating access to high quality near-real-time globally distributed magnetic observatory data. It has achieved this by establishing six Geomagnetic Information Nodes to act as data collection centres, and by providing facilities to allow data (both preliminary and definitive) to be selected and downloaded from the INTERMAGNET web site (http://www.intermagnet.org). The full collection of definitive one-minute data from participating observatories sets is published annually on CD-ROM following independent quality checking. Many of these aspects of INTERMAGNET activities are documented in the INTERMAGNET Technical Reference Manual, which is available online. It is also fair to claim that INTERMAGNET serves society by promoting the efficient production of data that are incorporated into data products such as magnetic activity indices and global geomagnetic field models. Many new magnetic observatories were established at the time of the International Geophysical Year (IGY) in 1957 to provide data for Earth science research. INTERMAGNET is endeavouring to ensure that the global magnetic observatory network continues to serve the needs of science, and society, as we celebrate the 50th anniversary of the IGY. The history, current status and activities, and plans for the future of the INTERMAGNET programme will be described

Keywords: intermagnet, magnetic observatory, geomagnetic monitoring

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ASV040 **Oral Presentation** **3918**

Recent Progress in Exploiting Current and Future Satellite and Surface Data in Comprehensive Geomagnetic Field Modelling

Mr. Terence Sabaka
Planetary Geodynamics Laboratory Raytheon at NASA Goddard Space Flight Center IAGA

Nils Olsen

The IAGA Division V sessions cover an exciting array of topics which arebecoming more and more interrelated as advancements are made and interestsexpand. The International Decade of Geopotential Field Research has providedoutstanding satellite magnetic mapping missions, even as we anticipate theupcoming Swarm mission. These are supported by a high-quality network ofsurface observatories and a vast collection of near-surface magnetic surveyswhich are enabling, for instance, high-resolution models of the world's crustalanomalies. The comprehensive modelling framework of parameterizing and co-estimating all the major field sources in the data has so far provided a good separation of these individual fields. However, new analysis techniques are needed to take full advantage of this rich set of data if new levels of accuracy and resolution are to be achieved in models. At the same time, we must be mindful of both the physical and computational issues involved. This talk will review some recent, notable modelling efforts and will focus on some newly developed methods which have allowed progress towards a fully-consistent satellite-ground based field model, inclusion of 3-D induction effects, and the exploitation of satellite gradient information from such missions as Swarm, all within a comprehensive framework.

Keywords: geomagnetic, modelling

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ASV040 **Oral Presentation** **3919**

Data collection, archive, and, delivery via the WDC system boulder, 50 years of change

Mrs. Susan McLean
Division V Member IAGA

The World Data Center (WDC) system was created to archive and distribute data collected from the observational programs of the 1957-1958 International Geophysical Year. In those early years, data was often in the form of photographic traces such as magnetograms and as published yearbooks of observations with often detailed descriptions of the observatory and instrumentation. World Data Centers around the world maintained safe archives of these data. In latter years, they also provided digital summaries of the yearbooks and microfilmed analog data to preserve content. However, access to the data, especially high-resolution data was limited to on-site visits or costly copies of data shipped to scientists unable to visit physically the WDC. The 1980s and 1990s brought a period of increasing digitization. Data began to flow digitally at minute samples and increasing numbers of observatories converted to an all-digital form of data delivery. For a period, Data Centers were challenged to keep up with the flow of data, to properly document data in the absence of the yearbook, and to archive and exchange data without established or inadequate formats. In many ways this was a period of unmet expectations. Many WDCs, including those in Boulder, struggled to keep up with the plural requirements of format, archive, description, and delivery in a rapidly changing information technology environment. The last five years have seen a maturing in the WDC system leading to what now appears to be a more stable capability based on a flexible information technology base. Data are flowing at ever-higher resolutions in closer to real-time. Metadata and data standards designed to grow with time coupled with spatially-enabled databases, web services, and flexible delivery systems promise a delayed, but real, improvement in data collection, archive, and delivery for scientific use. This presentation will briefly review the changes over the years since the IGY and focus on the technological and social advances that seem hopeful for sustained archive and access of geophysical data for the next 50 years.

Keywords: world data center, data management, archive access

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ASV040 **Oral Presentation** **3920**

Geomagnetic indices: advances and challenges

Prof. Michel Menvielle
IAGA

Recent advances and present challenges in the field of geomagnetic indices are reviewed, from both academic (Solar Terrestrial Physics) and operational (Space Weather) point of views. A brief overview of indices used in Solar Terrestrial Physics and Space Weather will be first presented, with particular attention to what each index really represents in terms of physical processes. A review of published papers will be made. The abilities and limitations of geomagnetic indices will then be discussed. Finally, suggestions for achieving a better monitoring of present geomagnetic activity, and a better understanding of long term variability of solar climatology will be made.

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ASICDC041 **3921 - 3934**

Symposium
The investigation of low-latitude and equatorial geomagnetic variations since the International Geophysical Year 1957

Convener : Dr. Baldev Arora, Prof. Nguyen Thi Kim Thoa

The symposium will provide an open forum to present all aspects of geomagnetic variations at the equatorial and low latitude regions since the International Geophysical Year 1957. Papers describing the variability of equatorial electrojet on a global-scale, using ground and/or satellite data are especially welcome. Distinctive signatures of the equatorial magnetic field that signify solar and geophysical forcing and have applications in space weather predictions would be of particular interest. The analyses of EEJ data since 1957 up to the present time are of particular interest.

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ASICDC041 **Oral Presentation** **3921**

Pi2 pulsations at low and near-equatorial latitudes

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Zhao Hua

Our research efforts are concerned with the study of near-equatorial geomagnetic Pi2 pulsations. Pi2 pulsations represent irregular oscillations in the range of 45-200 sec periods, which accompany the active phase of the magnetospheric substorm. They have a maximum amplitude as large as one hundred nanoTesla in the auroral zone. The amplitude of Pi2 pulsations decreases both poleward and equatorward. At the latitude of plasmaspause projection onto the terrestrial surface there is a secondary maximum of intensity. It is currently beyond question that geomagnetic Pi2 pulsations have a primary high-latitude source occurring in the auroral zone. These oscillations are due to variations of currents as the electrojet develops. The secondary source occurs in the zone of plasmapause projection onto the terrestrial surface and can be caused by the development of a global mode in the Earths plasmasphere. It should be noted that such pulsations has a global character in mid-latitudes. Further, it should be noted that there is one further zone where the excitation of these pulsations can be different from high and mid-latitudes. It is the region of the geomagnetic equator. Our study of near-equatorial Pi2 pulsations was based on using the data from digital induction magnetometers installed at one Russian, one Japanese and two Chinese stations. The main conclusion from our investigation is that in near-equatorial regions at some instants of time there can occur an enhancement of the intensity of Pi2 pulsations and in some cases the decay of the pulsations. At this stage of research it is premature to say whether there is one further source of Pi2 pulsations in near-equatorial regions or whether there is some enhancement mechanism at work.

Keywords: magnetospheric substorm, pi2 pulsations, near equatorial latitudes

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ASICDC041 **Oral Presentation** **3922**

The Magnetic Variations of the Equatorial Electrojet and the Low-latitude Ionospheric Current Simulated by the Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM).

Dr. Vafi Doumbia
Geomagnetism and aeronomy ICDC IAGA

Astrid Maute, Art Richmond

In this work, the quiet-day magnetic variations of the Equatorial Electrojet (EEJ) and the low-latitude ionospheric current system have been simulated by the TIE-GCM. The results are compared with magnetic variations associated with the EEJ as observed on the ground during the March equinox and the June and December solstices, as well as on board low-altitude orbiting satellites, under approximately the same solar activity conditions. Furthermore, the influence of the thermospheric migrating diurnal and semi-diurnal tides have been specifically examined through the model, using tides from the Global Scale Wave Model as lower-boundary conditions for the TIE-GCM. It appears that the thermospheric tides play an important role in the longitudinal structure of the EEJ magnetic variations.

Keywords: equatorial electrojet, modeling, geomagnetic variations

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ASICDC041 **Oral Presentation** **3923**

Low latitude Pi2 pulsations: multisubstorm activity

Mr. Praveen Vohat
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Ashwini Kumar Sinha, Bashir Mohd. Pathan

Earlier studies of low latitude geomagnetic pulsations reveals that Pi2 pulsations are one of the best indicators of the magnetospheric substorms onset. The identification of such indicators is quite relevant for space weather prediction. In the present study we have looked into the simultaneous magnetic data from a chain of stations covering a longitudinal and latitudinal extent of 650 and 270 respectively in the low latitude region. Data of 6 hours (17-23 UT) on 31st August 2006 from the chain reveals a burst of Pi2 events having dominant frequencies at 11.72 mHz and 23.44mHz. A look into AE indices suggests that the burst of the observed Pi2 events may be associated with the multiple substorms on the day. Also, the sharp rise in the solar wind dynamic pressure throws a light on the generation of such pulses in the terms of dynamic equilibrium at the magnetopause boundary.

Keywords: substorms, low latitude, pulsations

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ASICDC041 **Oral Presentation** **3924**

Seasonal deformations in the SQ current system

Dr. Baldev Arora
Wadia Institute of Himalayan Geology Director IAGA

S.K.Bhardwaj

Regular Solar quiet-day (Sq) variation recorded at widely distributed stations have been extensively used to describe the nature and deformation in the overhead current system resulting from dynamo-action. Ever since the pioneering work of Father Mayud, rectilinear, tilted, deformed models are used to describe the nature of deformation which include intrusion of Sq current system from one hemisphere to the other resulting in the skewing of the elliptically shaped Sq current vortex. Since this skewing of vortex system is expected to produce a definite waveform in daily variation with characteristic latitudinal behaviour, the method of Principal Component Analysis is applied on the data from dense network of observatories along the Indian- Russian sector to quantify the extent and nature of Sq vortex deformation. While the latitude-time characteristic of the first principal component in horizontal and declination data describe the expected behaviour of symmetric Sq vortex, the second component shows typical waveform associated with clockwise and anti-clockwise skewing of the Sq vortex. The second principal horizontal component is small at low latitude but their amplitudes attain large magnitudes at mid-latitudes. Another characteristic behaviour of this waveform is the reversed behaviour between summer and winter months. In comparison the horizontal component perturbation effects associated with deformation are more conspicuous in declination. The combination of horizontal and declination waveforms are used to obtain the over-all picture of deformation in Sq current system with latitude and time. These secondary current patterns in winter are dominated by meridional currents along the sunrise and noon meridian which complete their circuits partially by return eastward currents at mid-latitude while a large parts merges merging with high latitude current systems. The seasonal behaviour of this current system will be described and discussed in terms of seasonal variation in ionospheric conductivities and dominant wind patterns.

Keywords: sq varaition, sq current vortex

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ASICDC041 **Oral Presentation** **3925**

Generation of Pi2 pulsations at the dayside dip equator (DDE) by the cavity resonance mode (CRM): a statistic study of the Pi2 pulsations observed on observations at Jicamaca (JIC) and Kakioka (KAK)

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Hui-Gen Yang, Zhuo-Tian Chen

Using high time-resolution and highly synchronized geomagnetic field measurements obtained at Kakioka (KAK, MLAT=27.2) and Jicamarca (JIC, MLAT=0.0), which are separated by ~10 hours in local time (LT), we examined 829 Pi2 events observed both at JIC and KAK from January 1999 to December 2003. We made statistic studies mainly focused on investigation of the differences of Pi2 pulsations observed at the dayside dip equator (DDE) and at the nightside low latitude (NLL). We found that the phase of Pi2 pulsations at the DDE lags behind that at the NLL about ~20 in average, and the amplitudes at the DDE are noticeably greater than those at the NLL. These features are consistent with previous studies. What important is that we found that the averaged frequency of Pi2 pulsations at the NLL is clearly higher than those at the DDE. Previous studies suggested that the Pi2 pulsations at the DDE are caused by oscillation of an electric field transmitted from the polar region. The property of Pi2 pulsation having lower frequency at the DDE than those at low latitudes has also been previously noticed and was suggested as an evidence for supporting the above suggestion. After investigating the occurrence histogram of the frequency difference (f=fJIC-fKAK) for the events observed by JIC on the dayside (~0800-1600LT), we noticed that close to half of the events has the identical frequency (| f |< 1.0 mHz) between the DDE and the NLL. According to the properties of f, we suggest that (1) Pi2 pulsations even at the DDE are also caused by the cavity resonance mode; (2) the events having the identical frequency at the DDE and NLL indicate that the same harmonic of the cavity resonance has been observed at both of the two stations; and (3) the differences of the averaged frequency between the dayside and nightside are caused by that higher harmonics of the cavity resonance mode are more likely to be predominantly observed on the nightside.

Keywords: dayside dip equator pi2, cavity resonance, pi2

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ASICDC041 **Oral Presentation** **3926**

On the magnetic quiet daily variation of the Earth's magnetic field sr above Vietnam, comparison with the other longitude sectors

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Christine Amory-Mazaudier, Minh Le Huy

In this paper we present the variation of the Earth's magnetic field observed during magnetic quiet days at Phu Thuy in the North Vietnam.The data analysed over one solar cycle exhibits the well known variations with the solar cycle and the season. Nevertheless, in Vietnam, for all seasons the declination of the Earth's magnetic field is flowing mostly in the Eastward direction (corresponding to a southward ionospheric current flow). This is different from the European African longitude sector observations. The Phu Thuy observations do not correspond to the planetary Sq/SR equivalent current system. We discuss these observations...

Keywords: magnetic variation, phu thuy observatory, solar cycle

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ASICDC041 **Oral Presentation** **3927**

Evidence for short correlation lengths of the noon-time equatorial electrojet inferred from a comparison of satellite and ground magnetic data.

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Hermann Lhr, Stefan Maus, Nandini Nagarajan

The current density of the noontime equatorial electrojet (EEJ) as determined from CHAMP data is highly variable between successive passes of the satellite, which are separated by 23 in distance and 93 min in time. An open question is to which extent this variability is caused by temporal or spatial variations in the ionosphere. Another important question is the connection between EEJ and global solar-quiet (Sq) current systems. We try to answer these questions by comparing the EEJ current density estimated from high-quality scalar magnetic field measurements of the CHAMP satellite with the magnetic horizontal intensity variations at six equatorial observatory pairs distributed across the globe. Data taken during the period 20002002 were used for the present study. We apply corrections for the effect of local time (LT) and Sq fields. By estimating the correlation coefficients between the ground and satellite data as a function of distances between measurements, new insights into the spatial structure of the EEJ have been obtained. The high correlation, when CHAMP passes directly over an observatory, decays quickly in eastern and western directions. Typically, within 15 of longitudinal separation between satellite and observatory, the correlation falls well below the statistical significance level. This observation holds for all longitude sectors. Interestingly, the correlation between CHAMP-inferred EEJ strength and observatory differences breaks down for the observatory pairs, outside of a 4 latitudinal band. This implies that the EEJ and Sq variations are uncorrelated for periods up to 1 hour. Additionally, it was found that monitoring of the EEJ can be performed best if the reference observatory is 4 to 5 apart from the dip equator.

Keywords: equatorial, electrojet, geomagnetism

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ASICDC041 **Oral Presentation** **3928**

Analysis of the equatorial electrojet magnetic field over West Africa

Dr. Arnaud Chulliat
IAGA

Yves Cohen

The equatorial electrojet is a thin electrical current flowing along the magnetic dip-equator on the day side of the Earth. In March 2006, two new magnetic stations have been installed by IPGP in Mali along the same meridian, under the Northern flank of the electrojet, at about 2 latitude from each other. These stations are temperature controlled and are recording magnetic variations on the three components every minute. Using data from this experiment and from magnetic observatories in MBour, Tamanrasset and Addis Ababa, we analyze the variability in latitude and longitude of the equatorial electrojet in this area, as well as his relationships with the underlying Sq current system. We also compare ground-based measurements of the electrojet magnetic variations with data from the CHAMP satellite, from which the internal and magnetospheric fields are subtracted using a global geomagnetic field model.

Keywords: equatorial electrojet, sq currents, ionosphere

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ASICDC041 **Oral Presentation** **3929**

Investigation of equatorial geomagnetic variations in India (1957 to 2007)

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J. L. Saini, J. S. Tariyal

Geodetic & Research Branch of Survey of India is the only organization in the country mandated to prepare isomagnetics charts at a time interval of every 5 years. More than 183 repeat stations at spacing of 200 to 250 km apart have been set up all over the country and geomagnetic observations are taken once in 5 years to study the secular variations in the earths magnetic field. The first magnetic Survey of India, which embraced the whole of India, was undertaken in the year 1901 to 1913. The results were reduced to epochs 1909.0 and 1920.0 and published as charts showing equal values of magnetic Declination, Horizontal Force, Vertical Force and Dip. The second magnetic epoch chart 1931.0 was published and then the committee of the IUGG (International Union of Geodesy & Geophysics) on magnetic charts recommended at Oslo in 1948 that the world charts of geomagnetic elements as well as isoporic charts should be drawn in frequent intervals. From then on Survey of India has been measuring the geomagnetic elements systematically with state of the art equipments available at any particular time frame. This paper discusses the low latitude and equatorial geomagnetic variations observed and analysed for the past 50 years that is from the international geophysical year 1957 to till date. It has been found that the vertical component of the geomagnetic force has symmetry about the dip equator and has a range variation upto 900 to 1000 nT in the past 50 years. In other words we can conclude that the shift of the dip equator is about 20 to 25 nT (Appox.) per year. The actual field observed values of the geomagnetic elements H, Z and D at the 20 repeat magnetic stations falling in the equatorial regions in along with the charts showing the migration of the dip equator southwards will be presented to the august gathering during the symposium.

Keywords: equatorial, field, india

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ASICDC041 **Oral Presentation** **3930**

Association between the strength of equatorial electrojet current and variability in the SQ focus

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Sobhana Alex, B.D. Kadam

The daily variation in the magnetic field at the earth's surface during geomagnetic quiet conditions is known to be resulted from the movement of the conducting ionosphere (E-region) across the earth's magnetic field. The ionospheric current system responsible for the Solar quite day variations is named Sq. The importance of the variations in the Horizontal component over the dip equator is mainly due to the high concentration of ionospheric current flowing in the east-west direction in a narrow band above the dip equator. On occassions, the northward field over the equator gets reduced to a stage to present a negative level below the night values, named as equatorial counter electrojet (CEJ). This phenomenon is due to the effect of the westward flow of electrojet current. There is considerable day-to-day variability in the equatorial electrojet strength and the development pattern of the Sq focal latitude. Sq current pattern as evidenced by the changing trend in the diurnal characteristics of North-South(X) and east-west(Y) field components are examined using the ground magnetic data from the equator to low latitude extending upto 300 in the Indian region for a almost 3 decades. The study mainly emphasizes the occurrence trend in the latitude of the Sq focus in the Indian region and its relation to the equatorial electrojet strength of variable characteristics.

Keywords: ionospheric current, dip equator, electrojet strength

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ASICDC041 **Oral Presentation** **3931**

Study of longitudinal variability from a spread of observatories to complement satellite measurements in the study of spatial and temporal variability of EEJ

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There are 4 principal longitudinal zones where EEJ measurements have been made and comparison has produced general global characteristics of EEJ. From recent results (Manoj et al, 2006) it is seen that spatial and temporal correlation drops off with longitudinal separation of about 20 deg. This result was established using correlation between ground and satellite measurements and holds significance for ionospheric phenomena. In the study of EEJ from ground magnetic variations, it is difficult to replicate this analysis because in the 4 regions around the world where EEJ has been studied, the emphasis had been to have latitudinal profiles. These were necessary and vital in the earlier studies. But with present instrumentation capabilities and data, further studies of day-to day variability and short wavelength perturbations of ionosphere can be carried out with longitudinal pairs/profiles. From an examination of past magnetic variations and the present observatory network, it is seen that a suitable combination of observatory pairs with required longitudinal spacing does not exist. A suitable experiment has been designed to estimate longitudinal variability from ground observations in the Indian region. It is proposed that for the Indian peninsula, 3 short profiles (latitudinal) may be set up: one on the peninsula (75E long) , which is already functioning, one to the west (60 E) on the Lakshadweep island chain and to the east on Andaman & Nicobar islands (90 E). The latitudinal spread is within 3 o +3 . The observatories would be setup using 3-component digital magnetometers, with independent absolute measurements. Satellite transmission of data to the processing location will be provided. There are obstacles to the commissioning and continuing data acquisition. These are location-specific and suitable measures will be taken to minimize them. The efficacy of this experiment lies in the longitudinal spacing of the observatories. In the light of recent results, this spacing would produce observations that can be correlated exhaustively with satellite measurements. Another aspect of EEJ variations that can be studied from this experiment is: effects of induction in the ocean and lithosphere on daily ranges. Since all of the observatories are near the coast or on islands, the separation of these effects would be significant

Keywords: equatorialelectrojet, longitudinal, indianregion

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ASICDC041 **Poster presentation** **3932**

The effect of dust particles on two-stream instability: a possible explanation for the persistence of ionization trails of Leonid meteor showers in the ionosphere.

Prof. Vaman Kulkarni

The excitation of electrostatic waves by the process of two-stream instability in the Earth-ionosphere is studied. Here we assume that the plasma is collisional, only electrons are magnetized and contains dust particles. We show that the losses by attachments of both ions and electrons on dusts, requires the drift velocities for wave excitation by the two-stream instability process is higher than ion acoustic velocities. This suggests that the wave growth rates and the generation of density irregularities in the ionosphere during meteor shower periods are reduced. We say that if the amplitude dependent diffusion rate is responsible for the decay of the ionization trails then the dust particles can be a reason for persistence of ionization trails seen during Leonid meteor showers of Nov 17, 1998. Here the ionization trails lasted 80 seconds to several minutes.

Keywords: electrostaticwaves dusts, meteors persistence, ionization trails

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ASICDC041 **Poster presentation** **3933**

Geomagnetic field oscillations at equatorial and low latitudes through Singular Spectrum Analysis

Dr. Sandeep Bhardwaj
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Monthly mean hourly values of geomagnetic field components D, H and Z for quiet days at equatorial and low latitude stations are analyzed to study the salient features of geomagnetic field oscillations in magnetic elements. The data used in this analysis is from 1958 -1993 at equatorial electrojet stations: Trivandrum, Kodikanal, Anamalainagar and from 1927-1997 at low latitude station Alibag. After correcting the data for common base, jumps etc. the geomagnetic Sq ranges and summed ranges are computed from the monthly mean hourly values and subjected to the data adaptive, noise reducing technique of Singular Spectrum Analysis (SSA) to isolate the Quasi-biennial oscillation (QBO). A QBO like signal with a quasi-periodicity of ~ 24-month is detected in Sq range spectrum. The pair of eigen vectors analyzed through SSA up to order 18 represent different oscillations of the field such as; 11-year, annual, semi-annual, 4-month, 14-month (Pole-tide) and a quasi-biennial oscillation etc. The Sq ranges and summed ranges of H-element shows clear 11-year solar cycle variations and after taking the 132-months running average, range and summed range are also plotted to suppress the 11-year solar cycle variation. The Sq ranges, summed ranges at all the stations and monthly mean sunspot numbers for the same period are also analyzed by a band pass digital filter method with unit response for 24 4 months in order to identify whether QBO signal at these stations is the result of dynamo winds or due to QBO like signature in the Suns atmosphere. It is found that a QBO signal with varying amplitude (period 24 to 26-months) occurs in all the three ranges and summed ranges of D, H and Z and also in the monthly mean sunspot numbers. The amplitude of the signal is stronger at equatorial electrojet stations in comparison with low latitude station Alibag and may be due to solar origin.

Keywords: quasi biennial oscillation, singular spectrum analysis, band pass digital filter

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ASICDC041 **Poster presentation** **3934**

Separation of normal and counter electrojet variations through Principal Component Analysis during IEEY

Dr. Sandeep Bhardwaj
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The technique of Principal Component Analysis (PCA) has been used to analyze the hourly mean values of geomagnetic field components D, H and Z along Indo-Russian chain of stations during International Equatorial Electrojet Year (IEEY) period. The dense network of geomagnetic observatories operated during IEEY provides good opportunity to study the equatorial and counter electrojet phenomena along Indian sector. These stations were installed along existing chain of observatories, extending from the dip equator up to the latitude of the Sq focus, measured digitally the minutes and five minutes values of three geomagnetic field components D, H and Z over a period of 18 months, from January 1992 to June 1993. The technique of PCA is found suitable to separate out the Normal Electrojet (NEJ) and Counter Electrojet (CEJ) variations and the first two Principal Components (PCs) are able to describe the characteristics of Sq, NEJ and CEJ related field variations. It is found that first principal component (PC-1) for H, D and Z varies as a function of time with latitude more systematically then PC-2 and depicts the well known Sq variations. However, PC-2(H) do not show any variations at all latitudes during NEJ days, while on CEJ days the PC-2(H) shows large negative excursion at equatorial stations. The CEJ related current system is determined by combining the hourly inequalities in D and H after subtracting the normal Sq variations and the nature of deduced flow path of source current favours superposition of additional current system caused by some global tidal modes in the dynamo region. The CEJ related current system, marked by intense westward current flow in equatorial belt. This intense westward current flow appears to close its path by forming a clockwise loop extending from dip equator up to the Sq focus region, with a well-defined focus around noon at about 13 degree dip latitude. It is suggested that the semi-diurnal asymmetric tidal modes plays an important role in the generation of CEJ events at equatorial stations.

Keywords: equatorial electrojet, sq variations, principal component analysis

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ASICDC042 **3935 - 3951**

Symposium
Advances in the investigation of equatorial aeronomic processes since the International Geophysical Year 1957

Convener : Dr. Polinaya Muralikrishna

Contributions related to advances in theoretical and experimental investigations on (i) Equatorial Electrojet (ii) Dynamical Processes and Coupling of the E and F-region and (iii) Plasma Irregularities, with special emphasis on the equatorial and low latitude regions are welcome. We invite contributions on the existing data base on the equatorial and low latitude upper atmosphere and ionosphere since the International Geophysical Year 1957. The main emphasis of the session will be on working out specific future plans of coordinated obser-vations especially in the developing countries in order to resolve problems in the area.

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ASICDC042 **Oral Presentation** **3935**

Satellite studies of low equatorial vertical plasma drifts

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John W. Jensen, S.-Y. Su

Equatorial vertical plasma drifts play a dominant role on the dynamics of the low latitude ionosphere and thermosphere. We present solar cycle, seasonal and magnetic activity dependence on equatorial ionospheric zonal electric field models derived from vertical ion drift observations from ROCSAT-1 between 1999 and 2004. The seasonal and local time variations of the quiet-time satellite drifts in the western American sector are in excellent agreement with the vertical drifts measured by the Jicamarca radar at the altitude of the satellite, and also with ionosonde-derived drifts from the Brazilian, Indian, and Pacific equatorial regions. The average quiet-time satellite drifts are also in general agreement with measurements from AE-E, but exhibit stronger longitudinal dependence even during equinox. The satellite measurements near dusk show particularly strong longitudinal variation in the American sector during June and December solstice. The longitudinal variation of the evening pre-reversal velocity enhancements measured by the satellite during equinox is in reasonable agreement with recent modeling studies, but the measured magnitudes are significantly smaller. We also present the first detailed study of the season, solar cycle, and longitude dependence of the equatorial disturbance drifts. These results will be compared with previous studies using radar observations and numerical modeling.

Keywords: satellite studies, plasma drifts, equatorial

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ASICDC042 **Oral Presentation** **3936**

Measurement of mesospheric temperature by three molecular airglow band at Kolhapur (16.8 N, 74.2 E), India

Prof. Girija Kumar Mukherjee
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The results of rotational temperature measurement of OH (6, 2), OH (8, 3) and O2 (0, 1) bands at Kolhapur (16.8° N, 74.2° E) during the period 2006-07 have been presented. An all-sky scanning photometer unit was used to monitor the night airglow emissions. Preliminary assessments of seasonal and temporal variations in rotational temperatures are examined and compared with satellite (SABER) measurement. It is shown that the seasonal change of rotational temperature in hydroxyl airglow is greater than 02 temperature variations in winter months. Wave activity can be seen in both intensity and temperature data. Relationship between the band intensity and temperature fluctuation for different vibrational bands has been discussed. The spectral analysis of the intensities and the rotational temperatures shows dominant periodicities of 6-12 hours showing the influence of atmospheric tides.

Keywords: airglow, gravitywaves, mesosphere

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ASICDC042 **Oral Presentation** **3937**

Spectral characteristics of waves in the mesosphere-thermosphere region from ground based airglow measurements at Kolhapur (16.8 N, 74.2 E), India

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The various nightglow emissions (OI 630 nm, OI 557.7 nm, OH (8,3), OH (6,2), OH(7,2) and O2 Atmospheric (0,1) band emissions) have been monitored from the ground at Kolhapur (16.8˚ N, 74.2˚ E, dip lat 10.6˚ N) by ground-based high resolution airglow equipments (All-sky imager, three tilting photometers, all-sky scanning photometers) on clear moonless nights in 2006-07. The Spectral analysis of the intensities and the rotational temperatures was done to get the periodicities of the atmospheric waves passing through the airglow layers moving from tropopause to the mesosphere and from mesosphere to upper atmosphere. Spectral features at various periods were found and investigated in relation to atmospheric tides and planetary waves. Harmonic analysis was also performed to daily and seasonal data sets to get the amplitude and phase of the dominant oscillations observed. The longer period of 8- 12 hour waves were observed in OI 630.0 nm and OI 557.7 nm emissions and shorter period (≤ 3 hours) waves are commonly detected in OH emissions showing the signature of gravity wave activity at that altitude.

Keywords: hydroxylairglow, mesosphere, tides

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ASICDC042 **Oral Presentation** **3938**

Effects of geomagnetic storm on F region plasma irregularities over India

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The causal relationship between F region plasma irregularities associated with Equatorial Spread F (ESF) and geomagnetic storm is being debated for the past few decades. In order to address this issue, the effectiveness of geomagnetic storm events on February 12, 2004, January 7, 2005 and March 21, 1998 on the F region ionosphere over low-equatorial latitudes for the development of Equatorial Spread F (ESF) events is investigated. These case studies involve simultaneous measurements of ESF irregularities by the Indian MST Radar at Gadanki (13.5oN, 79.2oE, dip lat 6.3oN), along with F layer measurements from Thumba (8.68oN, 77.0oE, dip lat 0.45oN) and SHAR ((13.7oN, 80.2oE, dip lat. 6.0oN), a station 100 km east of Gadanki. Based on the ionospheric observations at Thumba, vertical plasma drifts corresponding to the zonal electric field have been derived for all the three cases. In one particular case (March 21, 1998), as the temporal variations of F region layer height was considerably different over Thumba and SHAR, meridional winds are also derived based on the ionospheric observations at those stations. Simultaneous optical measurements of OI 630.0 nm airglow from the radar site are available for the first two cases and the same is available for the third case from Waltair (17.7oN, 83.3oE, dip lat 10.09oN), a station ~400 km east of Gadanki. The dawn-to-dusk component of interplanetary electric field (IEFy), wherever it is possible, is deduced using the interplanetary magnetic field and solar wind velocity measurements by Advanced Composition Explorer (ACE) satellite located at the first Libration point of the sun-earth system. The IEFy datum points, in each case, are time shifted using an appropriate methodology to calculate propagation lag between the satellite and ionospheric observations. Investigations using these data sets reveal that the prompt penetration of IEFy into equatorial and low latitude ionosphere did not trigger the onset of ESF as the polarity was westward on February 12, 2004. However, on January 7, 2005, IEFy triggers ESF in the post-sunset hours and causes a plasma plume event during pre-midnight hours. In the third case (March 21, 1998), zonal electric field reversal is delayed upto 2100 hr IST under the influence of storm. In addition to that, plume developments in the pre-midnight hours are observed irrespective of the polarity of the zonal electric field when the bottomside structure of ESF, extrapolated over dip equator, is found to lie well above 450 km. The details of these three cases will be highlighted in the presentation. Further, the present day view on the correlation between ESF and geomagnetic storm in contrast to the earlier view will be discussed.

Keywords: geomagnetic storm, equatorial spread f, prompt penetration

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ASICDC042 **Oral Presentation** **3939**

GPS Tec variation over Southeast Asian Region during magnetic storms

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In this paper we present some first results of the computation of the total electron content (TEC) of the ionosphere from the data of the GPS receivers in Hanoi (210250, 1054759"), in Hue (162733,1073533), in Ho Chi Minh city (105054, 1063335) and of some ones in the Southeast asian region as Kunm in China, Ntus in Singapore and Bako in Indonesia which creat one chain of GPS receivers nearly along 105E longitude to have ionospheric coverage from the 95E to 120E longitude and from -13N to 30N latitude. It were shown that this GPS receiver chain is very good for the studies of TEC variation in the Equatorial ionization anomaly (EIA) in the Southeast Asian region. In this region where the magnetic equator is nearly parallel to the geographic one, latitude-time TEC map shows a geometry symmetrically with respect to the magnetic equator in the quite-time. It seems that it is not the case for the american region where the magnetic equator is not parallel to the geographic one. The TEC during some magnetic storms were computed from the data of these GPS receivers. It shown clearly that during the early stage of the magnetic storm, the EIA expanded poleward with large increases of the TEC, this provided evidence of a penetration magnetospheric eastward electric field and a strong plasma effect associated with the upward ExB plasma drifts. In the recovery phase, one to three days after the storm sudden commencement,the EIA is significantly reduced, the TEC value decreases and the crests move equatorward. These observations suggest that one to three days after the SSC onset, in the recovery phase, the ionospheric disturbance dynamo has an important influence on storm-time ionospheric electric fields at low latitudes, which singificantly decreases the TEC value and affects the structure of the EIA. The comparisons between the vertical TEC derived from GPS data and the plasma frequency foF2 measured by ionosondes at the Hanoi and Baclieu observatories have been made.

Keywords: global positionning system, total electron content, magnetic storm

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ASICDC042 **Oral Presentation** **3940**

Possible effects of lower E-region dust particles on the electrojet current profile

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Dust particles, mainly of meteoric origin, present abundantly in the lower E-region can affect the equatorial E-region conductivities in several ways. Most of them remain electrically neutral and can affect the ion collision frequencies, especially in the lower E-region, and thereby alter the electrical conductivity of this region. This can lift the Cowling conductivity maximum by a few kilometers making it coincide with the observed electrojet current maximum. Charged dust particles in the lower E-region can considerably reduce the electrojet current density in this region, by capturing a large number of free electrons from this region. A clear evidence for this is the large difference between the electron and positive ion number densities observed in this region by in situ probes. Positive ion densities, at times, are seen to be an order of magnitude higher than the electron number densities in the upper mesospheric region. Rocket observations have also shown the presence of dust layers in this region charged positively on top and negatively at the bottom. Such dust layers can reverse the vertical polarization field locally and can even produce the phenomenon of counter electrojet. Model calculations of the electrojet current density taking into account these effects of dust particles is presented here.

Keywords: electrojet, meteoric dust, counter electrojet

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ASICDC042 **Oral Presentation** **3941**

Atypical k-spectra associated with topside equatorial spread-F irregularities

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Height variation of the k-spectra of intermediate, transitional and short wavelength electron density irregularities obtained with rocket-borne Langmuir probes are examined in the light of the existing theories of the generation mechanisms of equatorial spread-F irregularities. In certain height regions, atypical k-spectra, with characteristics different from those expected from the existing theories, are observed. While theory and laboratory measurements indicate a power law density fluctuation spectrum for gradient drift waves with spectral index in the range of 4.5 to 6.0, spectral indices estimated from observations reported here varied from 3.0 to 5.4 in the bottom side of the F-region, and from 2.5 to 3.0 in the topside. This puts in check the gradient drift instability as a generative mechanism of irregularities especially in the topside F-region. The spectral index expected for the large scale irregularities produced by the Rayleigh-Taylor instability mechanism is expected to be in the range of 2.0 to 2.5. The height profiles of k-spectra obtained during four rocket experiments conducted under different equatorial spread-F conditions are examined here. For one of the launches reported here, the k-spectra of electron density irregularities are compared with the k-spectra of electric field fluctuations. In the topside F-region, at transitional and short wavelengths the density spectra are expected to be much steeper than the electric field spectra. Present observations are not fully in agreement with this. Atypical behavior was noted in the electric field spectra too.

Keywords: spread f, irregularities, k spectra

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ASICDC042 **Oral Presentation** **3942**

Role of E- and F-region coupling in the evolution of equatorial plasma bubbles

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The International Geophysical Year (IGY) ushered in the era of artificial satellites. Since then, wealth of information about the important low latitude ionospheric phenomenon of equatorial plasma bubble (EPB) obtained from satellites and ground based radio techniques show the importance of the coupling of the equatorial F region with conjugate E regions through geomagnetic field lines, in the evolution of EPBs. In a transmission line analogy for the development of EPBs, it has been suggested that field-aligned currents carried by Alfven waves generated in the equatorial F region as the EPB starts to grow, couple the equatorial F region with the conjugate E-regions. Consideration of the subsequent flow of this current through the conjugate E regions introduces a time scale for the discharge of the EPB in its growth phase. Some of these theoretical developments are discussed in the context of observations of the EPB phenomenon since IGY.

Keywords: coupling, equatorial f, e region

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ASICDC042 **Oral Presentation** **3943**

Equatorial Aeronomy Then and Now

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Over the past 50 years there have been some major changes in the way we do research in aeronomy. In July 1957 there were no computers and no satellites. At that time Aeronomy was almost synonymous with ionospheric physics and geomagnetism. Even 5 years later, at the First Equatorial Aeronomy Symposium in , out of a total of 9 sessions only one included other subjects. Of the 16 specific recommendations which resulted from this same symposium, only one did not directly concern either ionosphere or geomagnetism. Fifty years on, the dynamics and photochemistry of the neutral upper atmosphere are major subjects of aeronomic research. Since the time of the IGY our observational capacity has increased enormously, especially through the use of satellites, but also through new ground-based techniques like incoherent scatter and lidar, and our ability to model aeronomic processes has improved beyond all recognition. In this presentation an attempt will be made to outline some of the advances which have been made in equatorial aeronomy over the past 50 years, and how our objectives and techniques have changed during this time.

Keywords: aeronomy, igy, equatorial

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ASICDC042 **Oral Presentation** **3944**

Simultaneous measurement of OH (6-2) Meinel band, OI 557.7 nm and O2 (0-1) atmospheric band emissions at Kolhapur (17 N), India

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Gravity waves and tides are important drivers of the dynamics of mesosphere-lower thermosphere (MLT) region and the variabilities induced by them are sharply reflected in airglow processes from this region. Simultaneous nightglow observations of OH (6-2) Meinel band, OI 557.8 nm and O2 (0-1) atmospheric band emissions from MLT region have been carried out at Kolhapur (16.8˚ N, 74.2˚ E), since January 2007. The rotational temperatures have been derived for both OH and O2 measurements. Several features of nocturnal variation of emission intensities and derived temperatures have been presented. Signatures of tide-like oscillations are frequently observed in nocturnal variation of emission intensities. Cross-correlation between intensity variations of different emissions and rotational temperature has also been investigated.

Keywords: airglow, mesosphere lower thermosphere, temperature

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ASICDC042 **Oral Presentation** **3945**

Data sources needed for data assimilation modeling of the equatorial ionosphere

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The ionosphere-thermosphere system at equatorial and low latitudes displays unique features due to the presence of the nearly horizontal geomagnetic field. The main characteristic feature in this region is the equatorial anomaly, which corresponds to ionization peaks that are located on both sides of the magnetic equator. However, superimposed on this characteristic feature are storm-time disturbances, mesoscale (100-1000 km) structures, and plasma irregularities. For the ionosphere, these include traveling ionospheric disturbances (TIDs), sporadic E layers, descending intermediate layers, ridges of enhanced ionization (storm enhanced densities), spread-F, and equatorial plasma bubbles. For the thermosphere, the disturbances include upward propagating tides and gravity waves, O/N2 depletions, and neutral gas perturbations in the regions containing both the equatorial anomaly and plasma bubbles. A powerful way of modeling this complex domain is via data assimilation models, but they are only useful if a sufficient amount of data is available. Unfortunately, much of the low latitudes is dominated by developing countries and oceans, and hence, data are sparse. The data that are currently available for assimilation into ionosphere-thermosphere models will be presented, as will typical results from an ionosphere data assimilation model. The data sources that are planned for the near future will also be presented.

Keywords: ionosphere, equator, data sources

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ASICDC042 **Oral Presentation** **3946**

Equatorial Low latitude Ionospheric Responses to Some Recent Intense Magnetic Storms

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A brief overview of equatorial and low latitude ionospheric responses to some recent intense magnetic storms will be presented. Large modifications can occur to the major phenomena of equatorial ionosphere, that is, ionization anomaly, spread F and electrojet processes, due to prompt penetrating and disturbance dynamo electric fields. Specific focus will be given to the response features over in comparison to other longitudes, during the super-storm of October 2003. For example, very intense prompt penetrating eastward electric field, in the evening sector caused unusually large vertical plasma uplift, at a velocity of the of the order of 1000m/s, as observed by the radar and digisonde over Sao Luis (Brazil), while no significant vertical drift was observed over Jicamarca (Peru). Quite contrary to the expectation the extremely large vertical drift did not lead to development of any intense spread F/plasma bubble event over . The scintillation S4 index as well as the range spreading in the ionogram was of less than normal intensity. Possible causes of such unexpected responses will be discussed. The Equatorial anomaly presented large intensification and latitudinal expansion, although over such responses were of less intensity than that reported for other longitudes. The latitudinal variation on the vertical drift as observed by digisondes over Fortaleza and Cachoeira Paulista suggested presence of intense poleward (possibly trans-equatorial) winds, that could be responsible for limiting the EIA intensity. These and related results will be presented and discussed.

Keywords: intensemagneticstorms, equatorialionosphere, electricfield

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ASICDC042 **Oral Presentation** **3947**

The Solar Wind Control of the Equatorial Ionosphere Dynamics during Geomagnetic Storms

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The interplanetary magnetic field, geomagnetic variations, virtual ionosphere height hF and the critical frequency foF2 data during the geomagnetic storms are studied to demonstrate relationships between these phenomena. We study 5-min ionospheric variations using the first Western Pacific Ionosphere Campaign (1998 - 1999) observations, 5-min interplanetary magnetic field (IMF) and 5-min auroral electrojets data during a moderate geomagnetic storm. The ionospheric 5-min variations at the equatorial stations which allow calculating in detail time delays of the auroral and equatorial ionospheric phenomena are scantily known. These data allowed us to demonstrate that the auroral and the equatorial ionospheric phenomena are developed practically simultaneously. Hourly average of the ionospheric foF2 and hF variations at near equatorial stations during a similar storm show the same behavior. We suppouse this is due to interaction between electric fields of the auroral and the equatorial ionosphere during geomagnetic storms. It is shown that the low-latitude ionosphere dynamics during these moderate storms was defined by the southward direction of the Bz-component of the interplanetary magnetic field. A southward IMF produces the Region 1 and Region 2 the field-aligned currents (FAC) and polar electrojet current systems. We assume that the short-term ionospheric variations during geomagnetic storms can be explained mainly by the electric field of the FAC. The electric fields of the field-aligned currents can penetrate throughout the mid-latitude ionosphere to the equator and may serve as a coupling agent between the auroral and the equatorial ionosphere. The storm wind driven electric fields which responsible for the larger amplitudes and longer lifetimes of the drift perturbations are discussed. It is shown that model simulations as disturbed ionospheric wind dynamo do not allow explaining a significant part of the experimental data. Additional investigations of the ionospheric characteristics are required to clear up the origin of the short-term equatorial ionospheric variations.

Keywords: equatorial ionosphere, magnetosphere, geomagnetic storm

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ASICDC042 **Poster presentation** **3948**

Study of the South Atlantic magnetic anomaly influence on the energetic particle precipitation

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The South Atlantic Magnetic Anomaly (SAMA), localized in the South Hemisphere, reaches almost all the region of the South Atlantic and extends longitudinally until the west coast of the South America. It is characterized as a region where the geomagnetic field has its lowest intensity and, therefore, there is a depression in its Field lines intensity. This depression anomaly occurs only in this region of the planet and its origin is attributed to the anti-symmetrical distribution of the electric currents in the interior of the planet. One of the consequences of the low intensity of the geomagnetic field in this region is that the energetic particles trapped in the Van Allens inner radiation belt can precipitate easily. The mirror point of the trapped particles over the SAMA is approximately 100 km of altitude, while is around 600 km in the magnetic conjugate point in the north hemisphere. In virtue of this, these energetic particles can precipitate over this region and dissipate their energy ionizing the atmospheric components, as occurs in the auroral region. This process is further enhanced during periods of geomagnetic storms and substorms. One of the usual methods to study the particle precipitation in the SAMA is through of the Imaging Riometer. The level of ionospheric absorption of cosmic noise is indirectly obtained from the data acquired with this equipment. From this data it is possible to infer the variation of the ionosphere electronic density. A higher ionospheric absorption indicates that an increase in the electronic density could have occurred in consequence of the energetic particle precipitation. Currently, there are three Imaging Riometer equipments in the SAMA region. The first one was installed in 1999 in the Southern Space Observatory - SSO/CRS/INPE - MCT, in So Martinho da Serra, Brazil, (29.4S, 53.8W). This observatory is strategically located near of the SAMA center, where the intensity of geomagnetic field is around of 23000 nT. In 2003 the second equipment was installed in Punta Arenas, Chile (53.1S, 71.0W). The third one was installed in Concepcion, Chile (37.5S, 72.7W). From these three equipments it has been possible to carry out studies to determine spatial scale and movement of the events of ionospheric absorption. The objective of this work is to present the analysis of data observed during a magnetically disturbed period with the Imaging Riometer installed at the Southern Space Observatory, as well as to give its briefcharacterization.

Keywords: geomagnetic anomaly, particle precipitation, imaging riometer

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ASICDC042 **Poster presentation** **3949**

The response of the equatorial and low latitude F-region in the Brazilian sector to intense geomagnetic disturbances during the early part of November 2004: A comparative study with the TIMEGCM model results

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In this communication, first a brief description of the new network for ground-based aeronomic observations of the equatorial and low latitude regions in Brazil, started in the year 2000, by the Universidade do Vale do Paraiba (UNIVAP) in collaboration with the Universidade Luterana do Brasil (ULBRA) and the Laboratorio Nacional de Astronomia (LNA/CNPq), will be presented. The observations include both optical (multi-spectral all-sky imaging systems) and radio (digital ionosondes and GPS receivers) systems. This will be important keeping in view possible collaborative studies with other groups in the developing countries. During the recent past, there has been an increasing interest in investigations related to ionospheric storm effects at equatorial and low latitude during Space Weather events. Intense geomagnetic disturbances were observed during the period 7-11 November 2004. Considering |Dst|max > 250 nT for super geomagnetic storm conditions, the period between 7-11 November had two super storms (|Dst|max = 373 nT at 07:00 UT on 08/11 and |Dst|max = 289 nT during 10:00-11:00 UT on 10/11). We present, interplanetary parameters (Advanced Composition Explorer (ACE) satellite - source http://www.srl.caltech.edu/ACE/ASC/), ionospheric sounding observations carried out at Manaus (2.9 deg. S, 60.0 deg. W; dip latitude 6.4 deg. N; a near equatorial station) and Sao Jose dos Campos (23.2 deg. S, 45.9 deg. W; dip latitude 17.6 deg. S; station located under the southern crest of the equatorial ionospheric anomaly), and GPS observations carried out at several stations by the Rede Brasileira de Monitoramento Continuo do GPS (RBMC) operated by the Instituto Brasileiro de Geografia e Estatistica (IBGE), during the period 6-11 November. Salient features from these observations in the equatorial and low latitude regions in the Brazilian sector during this intense geomagnetically disturbed period are discussed. The ionospheric observations in the Brazilian sector are also compared with the TIMEGCM model (run with high-resolution assimilative mapping of ionospheric electrodynamics (AMIE) inputs at high latitudes) results.

Keywords: equatorial aeronomy, space weather, timegcm model

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ASICDC042 **Poster presentation** **3950**

The effect of dust particles on two-stream instability: a possible explanation for the persistence of ionization trails of Leonid meteor showers in the ionosphere.

Prof. Vaman Kulkarni

P. Muralikrishna

The excitation of electrostatic waves by the process of two-stream instability in the Earth-ionosphere is studied. Here we assume that the plasma is collisional, only electrons are magnetized and contains dust particles. We show that the losses by attachments of both ions and electrons on dusts, requires the drift velocities for wave excitation by the two-stream instability process is higher than ion acoustic velocities. This suggests that the wave growth rates and the generation of density irregularities in the ionosphere during meteor shower periods are reduced. We say that if the amplitude dependent diffusion rate is responsible for the decay of the ionization trails then the dust particles can be a reason for persistence of ionization trails seen during Leonid meteor showers of Nov 17, 1998. Here the ionization trails lasted 80 seconds to several minutes.

Keywords: ionosphere irregularities, dust meteor showers, persistence ionization leonid

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ASICDC042 **Poster presentation** **3951**

The climatology of Equatorial Spread-F magnetic signatures

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Lhr, H., Rother, M.

The equatorial spread-F (ESF) phenomenon is a result of local ionospheric instabilities occurring after sunset. It is characterised by low electron density regions forming depleted magnetic flux tubes. The involved steep electron density gradients are especially critical for the reliability of radio wave based navigation and communication, such as GPS. Therefore, an increasing interest in the investigation of the properties and the evolution of ESF has developed during the past decades. ESF plasma plumes have been observed many times by ground-based instruments which gave important insight into the characteristics and evolution of an ESF event. New possibilities to approach the ESF global distribution are given by in situ satellite observations. These identify ESFs primarily by their nature of sudden plasma depletion. Observational evidence for magnetic field perturbations associated with ESF was first provided in the early 1990th. Motivated by these data, electromagnetic modeling studies have been initiated to disclose the ESF magnetic signatures and to understand the evolution of ESFs. However, the number of observations was insufficient for a long time due to the lack of missions carrying sensitive magnetometers. The CHAMP satellite carries among others a fluxgate magnetometer providing high resolution magnetic field measurements. It has been launched in July 2000 into a near-polar, circular orbit at an altitude of about 400km. An almost continuous data flow has been obtained until today. From these data we could reveal ESF magnetic signatures in the total field, as well as in the perpendicular components. An immediate explanation for the total field deflection is the diamagnetic effect. Perpendicular deflections imply field-aligned currents. Especially the total field signatures enable us to provide a climatology of the occurrence of ESF magnetic signatures. Therefore, we present their dependence on local time, magentic latitude, longitude, season and solar activity. Most of our results confirm the ESF distributions found by plasma depletion monitoring, others differ due to their different nature. The long term and precise magnetic data set up to 50Hz sampling will open new aspects for the understanding of the electromagnetic nature of ESF and can be used for comparison with electromagnetic ESF modeling.

Keywords: equatorial ionosphere, esf, magnetic signatures

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ASIDCH043 **3952 - 3976**

Symposium
The International Geophysical Year: A 50-yr Retrospective

Convener : Dr. Gregory A. Good, Dr. Ed Cliver

The International Geophysical Year (July 1957 - December 1958) was a watershed event in the geosciences. Described at the time as the most ambitious and successful co-operative effort in the history of science, the IGY has had a profound impact on the organization and conduct of the geosciences during the past half century. Conceived at a dinner party at the home of James Van Allen on 5 April 1950, the IGY was sponsored, nurtured, and carried out by the IUGG and the other cooperating international scientific unions of the ICSU through the Comit Spcial de lAnne Gophysique Internationale. All domains of the geosciences from the Sun to the Earth were covered. In this symposium, which is coordinated with U.02, we consider the long-term impact of the IGY on the development of the geosciences. The symposium will consist primarily of invited talks but contributions are solicited on topics including, but not limited to, organizational and institutional aspects of the IGY, personal accounts of IGY activities/discoveries, and retrospectives of the significance of the IGY for the various geophysical disciplines. Contributed presentations that cannot be accommodated in the oral session will be given as posters.

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ASIDCH043 **Oral Presentation** **3952**

Earthrise: the uniqueness of the IGY

Dr. Rip Bulkeley
IAGA

The paper will present an overview of the IGY which surveys its origins (scientific, political and military), organization (structures, scope, participation and finance), execution (national and international, professional and amateur, expeditionary and domestic), cultural and political impact, early scientific achievements, internal divisions and other problems (including human losses), and long-term scientific and other results. The IGY was shaped by the Cold War, but prefigured a future that might transcend it. It was a high point of modernism in the earth sciences, but it also included several post-modern elements, including a significant proportion of participating women (which varied with the local culture), the large-scale recruitment of amateurs, a preoccupation with public awareness, and an opening towards a polycentric, de-colonized global knowledge community. It was a finite, imperfect data-gathering exercise, but initiated a new stage in scientific understanding of the Earth within the solar system, based on near-global cooperation. Lastly, it was temporary but also permanent, above all through its system of World Data Centres. That is why it can never be repeated. (The paper will also glance at certain figures whom there has been a tendency to omit from the narrative of the IGY, including Julio Escudero, Johannes Egedal, Julius Bartels, Vladimir Beloussov and Maria Klyonova.)

Keywords: history, igy, cold war

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ASIDCH043 **Oral Presentation** **3953**

M.A. Ellison & the solar program of the IGY

Prof. Susan McKenna-Lawlor
Space Technology National University of Ireland Maynooth IAGA

Mervyn Archdall Ellison was born (1909) at Fethard-on-Sea in Co. Wexford, Ireland into a clerical and astronomical family. Through his early work in observing and analyzing solar flares he became well known internationally and, in due course, became associated with the planning of the International Geophysical Year (IGY), which was timed to coincide with a period of elevated solar activity expected to occur in 1957-58. The present paper traces how Mervyn Ellison in his capacity of World Reporter for Solar Activity on the Supervisory Committee of the IGY established at Dunsink Observatory (near Dublin) an International World Data Centre. Here, observations recorded by an H-α Lyot Heliograph he had set up at the Cape of Good Hope as part of an international flare patrol (designed to observe the Sun almost continuously) were systematically analyzed and correlated with a wide range of complementary, measurements forwarded to Dunsink from all over the world. The results obtained by Professor Ellisons team at Dunsink based on these records are briefly outlined. Also, what it was hoped the IGY would achieve in solar studies, and the influence the practices of the IGY can, with hindsight, be seen to have exerted on later solar research programs, are each discussed.

Keywords: solar, research, impacts

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ASIDCH043 **Oral Presentation** **3954**

The Greatest Legacy of the IGY: Antarctic Science as a Force for Peaceful Internationalism

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This presentation reviews the research programs that occurred in Antarctica as part of the International Geophysical Year (IGY). It also identifies the precedents for these scientific activities as well as the subsequent endeavors in Antarctica made possible by the IGYs model of successful international scientific cooperation. Most important, this presentation examines the political history of the southern continent and asserts that the Antarctic component of the IGY was implemented, in part, to blunt building national rivalries and cross-cutting interests in the southern continent. When cooperative IGY research programs did just that and inspired a dozen nations to negotiate the 1959 Antarctic Treaty, which facilitated further scientific cooperation in Antarctica, science became a central force in preserving political stability in the south polar region. Antarctic science and geopolitics reinforced one another over the subsequent half-century, and the resulting era of peaceful internationalism in that area has served as a model for other regions (i.e. outer space) and made Antarctica an essential site for basic space, earth, and biological research as well as targeted studies of the global environment.

Keywords: antarctica, science, international

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ASIDCH043 **Oral Presentation** **3955**

The Impact of the IGY on Studies of the Sun

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The solar program of the International Geophysical Year (IGY), including key institutions, observations, and scientific advance, is reviewed. Progress in solar research during the IGY is compared and contrasted with that for the corresponding ground-based ionospheric and auroral programs.

Keywords: igy, sun

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ASIDCH043 **Oral Presentation** **3956**

The IGY and the Promise of Openness

Dr. Fae Korsmo
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When the planners of the IGY met in the early 1950s, they focused on the requirements for synoptic observations, standardized instrumentation and measurements, and usable, accessible data. They faced a world in which not all geophysical data were available. Some remained classified, and some were too difficult to obtain in any usable format. The system of World Data Centers that emerged from the IGY dramatically changed the situation. While the efficacy of data collection and dissemination varied among the different disciplines, the guidelines set up during the IGY enshrined a set of behavioral norms to govern publicly funded science. This presentation discusses the World Data Centers as an important IGY legacy.

Keywords: data, history, policy

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ASIDCH043 **Oral Presentation** **3957**

The IGY and Internationalism in the Ocean Sciences

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Sir Frederick Brundrett opened a 1963 speech with the line: A world which spends more in a single year on research into space than it has done since the beginning of the century on research into the sea is mad. Oceanographers rushed to applaud the sentiment, as they fought in vain against rockets and space to gain some share both of the publics imagination and of governments deep pockets. It had been five years since the close of the IGY, and oceanographers still struggled to make the best use of the unprecedented scale and scope of the 1957-58 venture. This paper analyzes the scientific and institutional changes brought about by the IGY, both during and after the event itself. What disciplines flourished as a result? What geopolitical gains were there? Particularly in the Soviet Union, the United States, and European countries, how did the IGY alter the practice of oceanography? It also explores the ways that historians of the marine sciences have interpreted the IGY and its legacy. Some have argued that international cooperation was just a patronage strategy; others have pointed out its role in curbing cold war tensions; still others point out the lasting diplomatic results embodied in major treaties. In recent years we have looked to the IGY, with its focus on synoptic data collection, for the genesis of the scientific study of global climate change. This paper will assess these important questions, as they have remained pertinent to international oceanography over the past fifty years.

Keywords: internationalism, cooperation, cold war

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ASIDCH043 **Oral Presentation** **3958**

Conversations with IGY Participants

Dr. Gregory A. Good
History Department West Virginia University

Distressingly few people are still with us who can relate their personal experiences during the International Geophysical Year fifty years ago. This presentation will explore the available oral histories and the few video histories with such participants, including those of several who are now deceased. This presentation is meant to encourage both the scholarly use of existing oral histories and the recording of new oral histories of IGY participants.

Keywords: oral history, history, igy

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ASIDCH043 **Oral Presentation** **3959**

Notes on the Soviet IGY

Dr. Rip Bulkeley
IAGA

Because of the problematic status of the archives of the Soviet IGY Committee and the dearth of Russian historical research into the programme this paper will perforce be based on published and unpublished sources available outside Russia and on the authors interviews with Professor Valeria Troitskaya, the former secretary of the Soviet IGY Committee. Topics to be covered include: the decision to join; the formation and style of the national committee; the scope of the programme; major interventions at CSAGI level; regional leadership; other international aspects; scientific results; social aspects, including gender, public involvement and loss of life; and the long-term scientific and political effects of Soviet participation.

Keywords: soviet union, igy, history

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ASIDCH043 **Oral Presentation** **3960**

Sydney Chapman: Cold War Intrigue & Governance of the IGY

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The IGY of 1957-58 was not insulated from the pressures of the Cold War -- indeed, it was buffeted by them no less than other foreign policy initiatives. A particularly revealing example of the complex interplay between international science and the state came when Sydney Chapman and other IGY leaders wrestled with the thorny question of which China would take part in the IGY. Because Communist China was undeniably the stronger scientifically, Chapman saw it as the most desired partner. The U.S. Department of State saw otherwise. Drawing on a wide range of unpublished letters and recently declassified documents, this paper explores the profound tensions between universalism and elitism, two of the important dimensions of scientific practice.

Keywords: igy, history, chapman

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ASIDCH043 **Oral Presentation** **3961**

The IGY and American Popular Culture

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Twenty-five years after the International Geophysical Year, Donald Fagen, longtime co-leader of the band Steely Dan, released the song I.G.Y. The imagery evoked by that song influenced the lives of many of us growing up in the U.S. in the 1950s. Now, 25 years further on, I will consider from my vantage point as a geophysicist and a child of the fifties some aspects of the IGY and American popular culture. How was the IGY imagined by the American public? Was this international cooperation at its finest? The epitome of space age science? An exploration into realms little known? Or just another manifestation of the Cold War?To consider these questions, I will draw upon a personal collection of memorabilia, mostly contemporary with the IGY, as well as other media. Writings comprise the major portion of the collection, ranging from popular book-length accounts of the complete IGY endeavor by journalists (Walter Sullivans Assault on the Unknown) and scientists (J. Tuzo Wilsons IGY: The Year of the Moons; Sydney Chapmans IGY: Year of Discovery); to multiple-part magazine layouts in Life (5 issues) and National Geographic (8 issues); to humor by intention (Walt Kellys G.O. Fizzickle Pogo) and by happenstance (Sir! magazines Did the Lapp mistresses eat the Russian geophysicist?); to science fiction (James Blish, The Frozen Year; Curtis Fuller, Mysteries of the IGY, Fate Magazine, the same issue which also contains Are nude Tibetan lamas the abominable snowmen ?); to books on Antarctica (Rear Admiral George Dufek, Operation Deep Freeze) and the satellite era (Willy Ley, Man-Made Satellites); to childrens literature (Martin Gardner, IGY: Sciences greatest challenge, in Childrens Digest). Two contemporary jazz charts used the IGY as a theme (Shorty Rogers A geophysical ear, and Gil Melles Dedicatory piece to the geophysical year of 1957). And films can assist in the contextualization of the IGY. Around the World in 80 Days (1956) was a story about a shrinking world, and soon thereafter satellites were orbiting the Earth in 80 minutes. New realms were being explored in Antarctic Crossing (1958), Journey to the Center of the Earth (1959), and Voyage to the Bottom of the Sea (1961). Yet there was also fear of the unknown, embodied in a horror movie that sent me cringing beneath my theater seat as a young boy, First Man Into Space (1959). There were ramifications of this era for many aspects of American culture, including a re-emphasis on science education, prompted by fears that we were falling behind our IGY collaborators and Cold War opponents (Arthur S. Trace, Jr., What Ivan Knows That Johnny Doesn't). Perhaps this was an impetus which molded some students of that generation to become the scientists we are today.

Keywords: igy, history, culture

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ASIDCH043 **Oral Presentation** **3962**

The IGY and Greenland Ice Core Research

Mrs. Maiken Lykke Lolck
Steno Department PhD student IAGA

Today ice core research is a significant research area within the field of paleoclimatology. Through the study of ice cores that are up to several kilometres in length it is possible to reconstruct climate changes many hundred thousand years back in time and in great detail. Because many climatic parameters such as atmospheric composition, prevailing wind patterns, temperature, precipitation and volcanic activity can be studied simultaneously in the ice cores, these studies play a significant role in the current debate on global climate change.The first drillings of polar ice cores were conducted around 1950 and in the early 1950s the Swiss-born geologist Henri Bader proposed a program to deep-drill into the polar ice caps. Around the same time Danish physicist Willi Dansgaard developed his theory of the isotope thermometer, and in an article in 1952 he proposed a study of the Greenland ice cap to reconstruct paleotemperatures. Thus the basic ideas of climatological ice core studies were present in the early 1950s but the methods of ice core analysis were still in their infancy and most important of all the financial and technological means necessary to drill into the ice caps were absent.In the talk I discuss how the International Geophysical Year 1957-58 worked as a catalyst for the emerging field of ice core research. In the planning of the US IGY program Henri Bader used his membership of the National Academy of Sciences Committee on Polar Research to promote a U.S. ice drilling program and at the same time the strategic and military interests in the Arctic that were also an important factor in the U.S. support for the IGY provided the means for conducting deep drillings in northern Greenland. During the French IGY expedition to the Greenland ice cap, Expdition Glaciologique Internationale au Groenland, a series of short ice cores were drilled. Because Greenland is Danish territory Willi Dansgaard heard of the French program and established a contact through the Danish authorities that oversaw all research activities in Greenland . This collaboration led to the first systematic isotope studies of ice cores and proved Dansgaards concept.I will also discuss how the success of the ice coring program during the IGY led to the establishment of a post-IGY program, which resulted in the first penetration of an ice sheet at Camp Century in northern Greenland in 1966. At this time collaboration between Willi Dansgaards Danish group and the program was established and the revolutionizing study of the Camp Century core that revealed climate changes more than a hundred thousand years back in time was accomplished. Since then ice core research has grown to a multinational research program with short and deep ice cores being drilled in both polar areas as well as on tropical glaciers and it continues to provide ground-breaking knowledge on the mechanisms of climate change.

Keywords: climate, glaciology, icecore

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ASIDCH043 **Oral Presentation** **3963**

The Impact of the IGY on Seismology

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The IGY was a paradox, conceived as a beacon of international scholarship and cooperation, yet very much part of, and to some extent fueled by, the enormously charged political era. The impact of the IGY on seismology cannot be divorced from the impact of the larger tide of which it was a part, namely that set into motion by the advent of the nuclear era and the attendant need for nuclear monitoring. The formerly small discipline of seismology suddenly found itself center stage, with levels of financial support that had previously been unimaginable. With such an enormous infusion of resources, the field might have found itself co-opted, its scientific objectives subjugated by political agenda. This clearly did not happen. Instead, within the span of a single decade the field of seismology was modernized, energized, transformed. Within this transformation the IGY played a small but important role. Seismology was only a small part of the overall IGY program, receiving about 2% of the funds committed by the United States. While modest, this representeda significant infusion to the field at the time. For example, the US-IGY contribution to seismology was approximately five times the annual operating budget of the Caltech Seismological Laboratory in the early 1950s. During the IGY, 16 long-period seismometers were deployed in far-flung locations including Bolivia and, notably, Antarctica--again, a modest effort that represented a substantial infusion of new resources. Prior to the IGY, global monitoring relied on a patchwork of research netowrks, including the Jesuit network in North America. The contribution of the IGY to seismology was quickly expanded upon by far more substantial efforts aimed at monitoring and discrimination funded by the Vela Uniform Project, initiated by President Eisenhower in 1959. Under this program, the first true global monitoring network, the WWSSN, was built. It comprised 120 standardized instruments at an initial cost of nearly 10 million U.S. dollars (1960s dollars). The WWSSN and the support for seismological research under Vela Uniform truly transformed the field of seismology. Arguably the most important impact of the IGY was the extent to which it set the tone for these later efforts, in particular establishing the leadership role for the field's stop scientific advisory groups in setting the directions of future programs.

Keywords: seismology, history, igy

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ASIDCH043 **Oral Presentation** **3964**

IGY: Springboard for Atmospheric Science Research

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Meteorologists from around the world had shared information since the mid-19th century—an absolute necessity for this budding international science. However, except for a few simultaneous balloon launches in early 20th century Europe, the IGY presented the first opportunity for atmospheric scientists to simultaneously collect a wide variety of data from around the world that could then be stockpiled for later analysis. The success of the IGY for atmospheric research, combined with advances in numerical weather prediction in the late 1950s and early 1960s, inspired atmospheric scientists to continue coordinating multi-national exercises whereby massive amounts of data from a variety of platforms could be collected in a relatively short period of time and then analyzed. Starting with the Global Atmospheric Research Project (GARP) in the 1960s, multi-national projects and exercises continued throughout the end of the century, providing the data needed for advanced atmospheric models. Fundamentally, all of these projects were based on the IGY model of national and scientific cooperation and data sharing, and enabled participants to successful execute the exercises that followed.

Keywords: meteorology, projects, history

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ASIDCH043 **Poster presentation** **3965**

Russian research in Antarctic oases from IGY to IPY

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The International Geophysical Year (IGY) is now often considered as the starting point in extensive international scientific research in Antarctica. One of the faces of these investigations was active scientific exploration of Antarctic oases ice-free lands in the coastal zones of Antarctica from tens to thousands square kilometers. These are the territories where most of the Antarctic scientific stations are situated, and in last years they also became objects of tourism with growing anthropogenic load. Author systematizes details of Russian scientific activity in East Antarctic oases for the last 50 years-from IGY to the International Polar Year (IPY). Types and sites of the investigations in glaciology, meteorology, biology, cartography, geology, geomorphology, paleogeography, and hydrology are listed. The most multifaceted and the most successful scientific results were obtained by Russians in Bunger Oasis, in Schirmacher Oasis and in Larsemann Hills. They put the lakes ecosystems of these oases among the most extensively studied objects in East Antarctic. Data obtained in analysis of the oases water reservoirs sediments provides chronologically reliable pattern of climate variability in the region during the Holocene. The results of the Antarctic oases investigations are presented in number of maps in the Atlas of Antarctica and in numerous publications. Most of the Russian data is kept in library funds of the Arctic and Antarctic Research Institute, St. Petersburg. The analysis also shows the gaps in understanding of some dynamical characteristics of the geosystems of the Antarctic oases and the necessity of generalization of the already available scientific data, planed to be made during the period of IPY. Importance of international scientific exchange in future investigations and estimation of the anthropogenic load on the Antarctic oases are emphasized.

Keywords: antarcticoases, ipy, igy

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ASIDCH043 **Poster presentation** **3966**

Italian activities during IGY and the post-IGY expansion of Geophysics in Italy

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Antonio Meloni

IGY offered a very appropriate and timely proposition to undertake a series of coordinated observations of various geophysical phenomena all over the globe. The participation of Italy to the IGY activities was inserted in the broad international effort that followed this initiative. Italy participated to observations and studies in many of the proposed areas in particular geomagnetism and ionospheric physics, with the installation of observatories and updating and regular running of geophysical observations. Seismology, cosmic rays and also other fields of science in the geophysical spectrum were improved. Although much of the work was undertaken in Italy some attention was also devoted to other areas of the world, in particular Antarctica, where Italy participated in seismological observations. In this presentation a summary of these activities and their results will be shown and the post-IGY growth of Geophysics in Italy will be discussed enlightening the importance of this historical event on the assessment of geophysical observations and scientific investigations in Italy.

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ASIDCH043 **Poster presentation** **3967**

The Politics of IGY Philately

Dr. Rip Bulkeley
IAGA

A chart showing stamps issued for, or in association with, the International Geophysical Year between 1957 and 1961 [sic]. Stamps are divided between those which did and those which did not explicitly refer to the IGY, and then arranged according to dominant theme, such as Oceanography or Territorial interests Antarctica. A short unpublished paper with this title will also be available.

Keywords: igy, philately, culture

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ASIDCH043 **Poster presentation** **3968**

An IGY Roll of Honour

Dr. Rip Bulkeley
IAGA

Analysis of 110 deaths of people taking part, in different capacities, in the International Geophysical Year and International Geophysical Cooperation, from the first arrival of Antarctic expeditions in January 1955 to the annual relief of stations in January 1960. A full listing can be provided and further information on seven incompletely listed cases would be welcome.

Keywords: igy, mortality, antarctica

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ASIDCH043 **Poster presentation** **3969**

The Hermanus Magnetic Observatory and the IPYs: Past, Present, and Future.

Dr. Peter Sutcliffe
Hermanus Magnetic Observatory Hermanus Magnetic Observatory IAGA

The Hermanus Magnetic Observatory (HMO) had its origin in 1932 during the 2nd International Polar Year (IPY 2); consequently, 2007 and the 4th International Polar Year (IPY 4) coincide with the HMOs 75th anniversary. Since its establishment, the HMO has actively participated in the worldwide network of magnetic observatories, whose core function is to monitor and model variations of the Earths magnetic field. Over the years, the scope of the HMOs activities have increased and presently include fundamental and applied space physics research, science outreach, and the provision of geomagnetic field related services. The HMO is responsible for research infrastructure and data used to monitor the near Earth space environment, including the maintenance and operation of an HF radar in Antarctica, which forms part of SuperDARN , and the collection and distribution of data from the South African ionosonde network. In celebration of it 75th anniversary and as part of its IPY 4 activities, the HMO is launching a project entitled Ihlabathi: Core to Space. (Ihlabathi is the Xhosa word for Earth.) The central theme is based on features of the geomagnetic field unique to the southern African and Atlantic regions, which arise in the Earths core and which have effects extending into space. As part of the IGY+50 anniversary, the HMO will register as the Regional Space Weather Warning Center (RWC) for Africa under the auspices of the International Space Environment Service (ISES).

Keywords: magnetic observatory, superdarn, ionosonde network

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ASIDCH043 **Poster presentation** **3970**

Sydney Chapman and his relation to geophysics IB Germany

Prof. Wilfried Schrder
geophysical commission scientist IAGA

The relationship of Sydney Chapman with Julius Bartels,Luwig Biermann, Hans Ertel, Gerhard Fanselau, Adolf Schmidt has been described in detail.

Keywords: chapman, geophysics, germany

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ASIDCH043 **Poster presentation** **3971**

On the work of amateurs in the auroral and aeronomy program during the IGY

Prof. Wilfried Schrder
geophysical commission scientist IAGA

The work by amateurs in the field of a) noctilucent clouds, b) increased airglow, and c) auroras has been investigated and described in detail. It is shown that only with their work and activity many results in this research fields could be studied. The work of amateurs plays a important role during the auroral and aeronomy programme.

Keywords: igy, amateurs, noctilucentclouds

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ASIDCH043 **Poster presentation** **3972**

Impact of IGY on Indian Geo-science Activities

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Sobhana Alex

The International Geophysical Year (IGY) provided a major thrust for the development of observational techniques for atmospheric and space sciences in India. Though Indias participation in the international collaborative programmes is almost two centuries old in the field of geomagnetic measurements, the expansion activities took a leap with the setting up of the two magnetic observatories in the equatorial low latitudes in India during IGY. Utilizing the basic advantage of the geographical location of India , having the position of the magnetic equator in the southern part of India and latitudinal coverage to extend up to the latitudinal position of the Sq current systems in the northern end, various national and international programmes were initiated in the field of the science of geomagnetism. Trivandrum mangnetic observatory, which was set up during IGY almost at the magnetic equator, provided support for the Indian rocket programme which grew into a full fledge Indian space programme leading to the birth of Indian Space Research Organization. In view of the importance of geomagnetism to the space phenomena, brought out by IGY, the Colaba and Alibag Magnetic Observatories were reconstituted into a full-fledge autonomous research organization known as the Indian Institute of Geomagnetism, Mumbai, currently functioning under the Department of Science and Technology. The special programme of the magnetic meridian project along the 75oE longitude belt gave an impetus to the study of geomagnetism in the entire low latitude belt. Participation in the International Magnetosphere Study, Solar-Terrestrial Energy Programme (STEP) etc. led to new infrastructure developments in India in the field of upper atmosphere, magnetosphere and solar physics, and the Indian scientists contributed significantly in the exploration of the near and far space environment of the planet earth.

Keywords: igy, geomagnetism, indian geosciences

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ASIDCH043 **Poster presentation** **3973**

Earth's Polar Regions' - A New Web-Based Educational Resource for the Public

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In support of IPY, a new educational resource on the Earth's polar regions has been developed on the Windows the the Universe website (http://www.windows.ucar.edu), sponsored by the National Center for Atmospheric Research in Boulder Colorado and the US National Science Foundation. The Windows to the Universe website is a high traffic education and outreach website spanning the Earth and Space Sciences, with over 7000 pages of content, interactives and classroom activities offered at 3 levels of sophistication for users of different ages in both English and Spanish. To support the interest of curiosity driven informal learners, as well as classroom based instruction, the website includes content on related topics in the humanities. The website is accessed by over 16 million visitors per year, corresponding to over 130 million page views annually, making it one of the most highly visited educational websites on the geosciences. The new "Earth's Polar Regions" section of the website includes content on polar geography, geology, magnetism, atmospheric structure, oceans, the cryosphere, polar life, climate change at the poles, arctic cultures, and polar exploration as well as links to "Postcards from the Field" from researchers and links to other quality web-based resources on the Poles. We will be adding classroom based activities, interactives, and expanding content in this section over coming months.

Keywords: polar, education, ipy

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ASIDCH043 **Poster presentation** **3974**

The process and management of geophysical information in national geophysical database of Iran since IGY

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Mining and Geophysics Shahrood University of Technology IAGA

The IGY was a year and a half of comprehensive global geophysical activities by the scientists of 67 nations in 1957-58. Discoveries by the earth satellites launched those years, new geophysical findings about oceans, and new developments in geophysical measurements for mineral exploration were great advances for the time. Now in the age of Information and Communication Technology (ICT), the acquisition, processing and use of geophysical information, for sustainable and comprehensive development appear to be essential, especially considering its ever-increasing applications in various fields. In addition, as discussed below, the use of powerful databases and computer facilities as well as new technologies, especially GIS and Web technologies, which not existed 50 years ago, is unavoidable. Although the use of geophysics in Iran is dated to the first half of the twentieth century, unfortunately the collected geophysical data had not been compiled comprehensively and extensively by any organisations or institutions until recently. In some cases, we can see that the companies or institutions, carried out the geophysical surveys, are still unknown, or no reports on the geophysical surveys exist. So far, A few ten thousands large or small geophysical projects, with various aims or purposes, have been performed in the country. Even some of the projects have been executed in a specific area several times unnecessarily. This means that either the managers of the projects have been unaware of the previous geophysical studies in the area, or the previous geophysical data and results have been unavailable or inaccessible. Therefore, it is necessary to consider the establishment and development of a database for keeping all the geophysical data, accessible by public or geophysical experts, in order to get benefits of the previous studies and also avoid of wasting time and costs for their repetitions. Due to the existence of many geophysical data production organizations and enormous amount of geophysical data or projects carried out in the country, in this stage we have only considered to establish a land geophysical database as the executed airborne and marine geophysical projects in the country, are less important and much less in number compared to the land geophysical surveys carried out in the country. Considering the difficulties and also conclusions and recommendations made as a result of investigation of geophysical databases in other countries, the policy and later the strategies for the establishment of the database and collecting data were decided by National Geosciences Database of Iran (NGDIR). The policy was decided with the aim to present the geophysical data in a Geographic Information System or GIS-based method and accessible to pubic (except some data due to confidentiality or other justified reasons) via internet. One of the most crucial phases of this work was to recognise private companies and enterprises (whether small or large) as well as governmental organisations involving in geophysical projects and also people with some basic expertise and experience in this field inside the country. The reason for this vast research was not to miss even any single geophysical work carried out in the country although this caused this phase to take a lengthy period to be accomplished. As a result of the completion of this phase of work, an almost comprehensive list of geophysical experts and companies in the country was published. In the next phase of the work, a unique simple questionnaire form comprising about 50 fields was prepared to be completed for every geophysical project or survey. The aim in this phase was not to generate a complicated and lengthy form containing many fields as this could result in failure of the work due to its impracticality. Some of the fields in the form were marked as mandatory to be filled (such as the name of the project, company or persons involving in the project, geographic coordinates of the survey area, etc.) while the other fields were designated to be optional. After completing the form for every

geophysical project carried out by the companies, organisations or persons inside the country, the data collected in the form were needed to be checked, edited and in some cases corrected. Many precautions were taken in this phase of work. Finally, the geophysical data were needed to be present in a standard database equipped with powerful Graphical User Interface (GUI) facilities. To visualize the data simply and quickly, it was decided to use a GIS-based program for this purpose. Ultimately some web programming or code was developed for the data in order to be accessible by public from a dynamic web page in internet.

Keywords: information, management, database

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ASIDCH043 **Poster presentation** **3975**

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The World Data Center for Solar Terrestrial Physics (WDC-STP) in Boulder, Colorado specializes in datasets concerning the sun, interplanetary space, the earth ionosphere and geomagnetic variations. The predecessor organization for the WDC-STP was formed during the IGY period in 1957 as the WDC-A for Airglow and Ionosphere. Subsequent to the IGY the WDC-A for Cosmic Rays, WDC-A for Solar Activity and WDC-A for Aurora (Instrumental and Visual) were moved from their respective host organizations and combined with the WDC-A for Airglow and Ionosphere to form the WDC-A for Upper Atmosphere Geophysics in 1968 which was later renamed the WDC-A for Solar-Terrestrial Physics in 1972. Other functions related to solar-induced geomagnetic perturbations were also transferred into the Boulder WDC-A between the IGY and 1970. In 1999 the designation WDC-A was removed and renamed the WDC-STP, Boulder. Within the emphasis areas, above, efforts are underway to improve the near-real time availability of geophysical data by taking advantage of modern communication networks and computer processing resources. In addition, the WDC-STP, Boulder is pursuing advanced capabilities for data mining and discovery and, within NOAA, the development of an enterprise system for data storage. Challenges the WDC-STP, Boulder must address are maintaining historical databases while acquiring an ever-increasing volume and diversity of new data.

Keywords: solar terrestrial physics, world data center, data management

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The world data centers: a successful 50 years and the challenges of the 21st century

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The WDC system was created to archive and distribute data collected from the observational programs of the 1957-1958 International Geophysical Year. Originally established in the , Europe, , and , the WDC system has since expanded to other countries and to new scientific disciplines. The WDC system now includes over 50 Centers in 12 countries. The WDCs have been very successful over the last 50 years in meeting the needs of ICSU programs. However, in the next 50 years, the WDC system will need to evolve to accommodate the changing needs of ICSU and the global scientific community. Advances in information technology, the implementation of new global scientific programs and the rapid increase in global, high-speed network connectivity will require the WDC system to adapt their current infrastructure, reorient their activities and implement new modes of operation. New requirements of existing ICSU programs like the IGBP, the activities of the new international science years (IPY, IHY, eGY, IYPE) and the implementation of the far reaching, long-term, Global Earth Observation System of Systems, will make new demands on the WDCs. The WDC system will respond by placing emphasis on modernizing its capabilities, expanding the WDCs into new disciplines, boarding the System geographically, especially into developing countries, and being more proactive in addressing new requirements from the ICSU and global scientific community.

Keywords: world data center system, igy, modernizing data management

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