Perugia, Italy July 2-13, 2007

IAGA

INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY

INTER-ASSOCIATION SYMPOSIA AND WORKSHOPS

Excerpt of “Earth: Our Changing Planet. Proceedings of IUGG XXIV General Assembly Perugia, Italy 2007”
Compiled by Lucio Ubertini, Piergiorgio Manciola, Stefano Casadei, Salvatore Grimaldi

Published on website: www.iugg2007perugia.it

ISBN : 978-88-95852-24-9

Organized by

IRPI

Perugia, Italy July 2-13, 2007

IUGG XXIV 2007 PERUGIA ITALY

EARTH: OUR CHANGING PLANET

High Patronage of the President of the Republic of Italy

Patronage of

Presidenza del Consiglio dei Ministri
Ministero degli Affari Esteri
Ministero dell'Ambiente e della Tutela del Territorio e del Mare
Ministero della Difesa
Ministero dell'Università e della Ricerca

Regione Umbria
Presidenza della Giunta

Provincia di Perugia

Comune di Perugia

SCIENTIFIC PROGRAM COMMITTEE

Paola Rizzoli	*Chairperson* *President of the Scientific Program Committee*	*Usa*
Uri Shamir	*President of International Union of Geodesy and Geophysics, IUGG*	*Israel*
Jo Ann Joselyn	*Secretary General of International Union of Geodesy and Geophysics, IUGG*	*Usa*
Carl Christian Tscherning	*Secretary-General IAG International Association of Geodesy*	*Denmark*
Bengt Hultqvist	*Secretary-General IAGA International Association of Geomagnetism and Aeronomy*	*Sweden*
Pierre Hubert	*Secretary-General IAHS International Association of Hydrological Sciences*	*France*
Roland List	*Secretary-General IAMAS International Association of Meteorology and Atmospheric Sciences*	*Canada*
Fred E. Camfield	*Secretary-General IAPSO International Association for the Physical Sciences of the Oceans*	*Usa*
Peter Suhadolc	*Secretary-General IASPEI International Association of Seismology and Physics of the Earth's Interior*	*Italy*
Steve McNutt	*Secretary-General IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior*	*Usa*

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.

JAS001 **Symposium** **(283 - 318)**

Convener : Dr. Philippe Cardin, Dr. Satoru Tanaka

Planetary cores: physics, chemistry and dynamics

JAS002 **Symposium** **(319 - 343)**

Convener : Prof. T. Harinarayana
Co-Convener : Dr. Kerry Key

Large scale imaging of the continental and oceanic lithosphere

---

JAS003 **Symposium** **(344 - 357)**

Convener : Prof. Yasuo Ogawa

Distribution of water and heat in the crust: Indication from EM studies

---

JAS004 **Symposium** **(358 - 388)**

Convener : Dr. Alexei Kuvshinov

Methodology in EM studies: Theory, modelling and inversion

JAS005 **Symposium** **(389 - 402)**

Convener : Prof. Franz-Josef Luebken, Dr. Richard Goldberg

The role of aerosols and dust in the middle atmosphere

JAS006 **Symposium** **(403 - 431)**

Convener : Dr. Elisabeth Blanc, Dr. Fernanda Sao Sabbas
Co-Convener : Dr. Craig Rodger, Prof. Davis Sentman

Electrodynamical and chemical effects in the middle and upper atmosphere generated by thunderstorms

---

JAS007 Symposium (432 - 492)

Convener : Dr. Dora Pancheva
Co-Convener : Prof. Edward Kazimirovsky

Response of the atmosphere/ionosphere coupling system to forcing from the Sun and the lower atmosphere

JAS008 Symposium (493 - 517)

Convener : Dr. Gufran Beig
Co-Convener : Dr. Jan Lastovicka

Long-term trends and changes in the atmosphere-ionosphere system

JAS009 Symposium (518 - 568)

Convener : Dr. Mangalathayil Abdu

Equatorial atmosphere-ionosphere coupling processes: responses to forcing from lower atmosphere and magnetosphere

JAS010 Symposium (569 - 578)

Convener : Prof. Hermann Luhr
Co-Convener : Dr. Huixin Liu

Magnetic field forcing of the thermosphere

JAS011 Symposium (579 - 590)

Convener : Dr. Travis Metcalfe

The Sound of Physics: Advances in coronal, helio-, astero- and terrestrial seismology

JAS012 Symposium (591 - 626)

Convener : Dr. Kumar Hemant
Co-Convener : Dr. Shigeo Okuma

Seismological, geological and tectonic interpretation of geomagnetic anomalies on continents and oceans

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

JAS001 **283 - 318**

Symposium
Planetary cores: physics, chemistry and dynamics

Convener : Dr. Philippe Cardin, Dr. Satoru Tanaka

This session focuses on recent advances in our understanding of the temperature, composition, structure and dynamics of the core of Earth, and of other terrestrial planets. Contributions on all related aspects are welcomed. We particularly invite contributions dealing with developments that cover the various disciplines bearing on this topic, including geodesy (e.g., rotation rate, wobble and nutation), core oscillations, seismology (e.g., structure of inner and outer core; differential rotation rate of the inner core), mineral physics (e.g., physical properties and phases at high pressure from experiments or from calculations), geochemistry (e.g. light elements, partitioning of radioactive elements), geodynamics (e.g., structural influences on dynamics and dynamo process, thermal and compositional convection, dynamic coupling of inner core, outer core and mantle) and energetic considerations (e.g. thermal history of the core, heat budget and Joule heating).

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

JAS001 **Oral Presentation** **283**

Elasticity and phase stability of iron and iron alloys at inner core conditions

Dr. Lidunka Vocadlo
Earth Sciences UCL

The nature of the stable phase of iron in the Earth's solid inner core is still highly controversial, with both laboratory experiments and seismology suggesting the occurrence of an uncharacterised phase transformation at core conditions. Theoretical calculations of phase stability are also undecided, as although such calculations predict the hcp phase to be the most thermodynamically stable, there is some possibility that the bcc phase could be stabilised at core pressures and temperatures by light elements such as silicon. Knowledge of the elastic properties of the candidate phases for the core is essential if we are to understand core structure, composition and evolution. Results are presented from ab initio finite temperature molecular dynamics simulations on both the elasticity and phase stability of iron and iron alloys at core conditions. A mineral physics model for the Earths inner core will be proposed.

Keywords: iron alloys, ab initio calculations, phase stability elasticity

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

JAS001 **Oral Presentation** **284**

Viscosity of Earth's Outer Core

Prof. Douglas Smylie
Earth & Space Science & Engineering York University IAGA

A viscosity profile across the entire fluid outer core is found by interpolating between measured boundary values, using a differential form of the Arrhenius law governing pressure and temperature dependence. The discovery that both the retrograde and prograde Free Core Nutations are in free decay (Palmer and Smylie, 2005) allows direct measures of viscosity at the top of the outer core, while the reduction in the rotational splitting of the two equatorial translational modes of the inner core (Smylie, 1999) allows it to be measured at the bottom. We find 2,371 pm 1,530 Pa.s at the top and 1.247 pm 0.035 x 10^11 Pa.s at the bottom. Following Brazhkin (1998) and Brazhkin and Lyapin (2000) who get 10^2 Pa.s at the top, 10^11 Pa.s at the bottom, by an Arrhenius extrapolation of laboratory experiments, we use a differential form of the Arrhenius law to interpolate along the melting temperature curve to find a viscosity profile across the entire fluid outer core. We find the variation to be closely log-linear between the measured boundary values. Since the motions involved in both the Free Core Nutations and in the translational modes are minute, the Rossby number for the motions is very small and the flows are laminar, giving viscosities that are measures of their molecular values. Similarly, the Arrhenius extrapolation of laboratory measurements yields molecular values. The local Ekman number is found to range from 10^-2 at the bottom of the outer core to 10^-10 at the top. Except in the very lower part of the outer core, Ekman numbers are in the range 10^-4 to 10^-5, or below, in which numerical dynamos operate, and in which laboratory rotating fluids experiments are carried out.

Keywords: viscosity, outer core

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

JAS001 **Oral Presentation** **285**

Dissipation on the core-mantle boundary and free librations of the multilayer moon

Dr. Alexander Gusev
Geopysics Kazan University, Russia IASPEI

Seismic profile in Apollo missions, moments of inertia of the Moon, magnetometric measurements, analyses of lunar rotational dissipation - this wide spectrum of information has given support for many arguments in favor of the existence of a hot viscous lower mantle, and also of a metallic core with mass exceeding 1% (up to 500 km) of the lunar mass with an impurity of sulfur and/or oxygen. Analyses of LLR data strongly detect a signature of dissipation in lunar rotation. The observed dissipation signature is a shift of pole of rotation by only 0".26, that is observed as a small metersized monthly variation. From additional LLR data and an improved gravity field from Lunar Prospector Williams et al. (2001) have found four dissipation terms, that can be explained with the combined effects of tide plus core: 2/3 of the this term comes from a tidal friction and 1/3 comes from the CMB friction without considering the CMB ellipticity. The inferred core radius has an upper limit 352 km for iron and up to 374 km if sulphur is present. Dickey et al. (1994) derived Q=26.5 based on a tide-only model: inelastic deformation of the mantle shape with amplitude proportional to the tidal Love number k2 and phase determined by the solid friction Q was considered. There are reasons to view the Moon as a body with a complex layered structure. The simplest model describing the Moon is a three-layer one: solid mantle / fluid outer / solid inner core. As result, four modes in free rotation appear. These are the chandler wobble (CW, Pcw = 74.08 yr), the free core nutation (FCN, Pfcn = 144.52 yr), the free inner core nutation (FICN, Pficn = 515.90 yr) and the inner chandler wobble (ICW, Picw = 100.21 yr). In this report we present the results of calculation of the free libration periods for different values of the dissipation coefficient R, which is connected to the qualitative parameter Q. The Moon model composed of a rigid mantle and a completely liquid iron core (with the density 7 gm/cm3) includes the dissipation at the core-mantle boundary. We have carried out the calculations of the free libration periods in dependence on a core's radius (from 200 km to 600 km) for different sets of dissipative coefficient R. The coefficient R corresponds to the viscose damping at the core-mantle boundary. Taking the various values of Q from LLR-analyses we have calculated a set of R. The magnitudes of R are in the diapason from 5 x 10^22 - 3 x 10^24 (erg x sec). The FCN is strongly correlated with the dissipation for core's radiuses Rc less than 400 km. This fact is very interesting indicator of internal processes, which may be derived from future observations in the frame of Lunar ILOM-project (Japan, 2012).

Keywords: lunar core dissipation

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

JAS001 **Oral Presentation** **286**

Seismic structure of the outer core from P4KP-PcP travel times observed with the J-array and IMS arrays

Dr. Satoru Tanaka
IFREE JAMSTEC IASPEI

PmKP is a seismic phase that is transmitted in the mantle and core as P-waves and particularly travels in the core for a long time with reflection at (m1) times underside the core-mantle boundary (CMB), which would be sensitive to the CMB shape and seismic velocity in the outer core. Especially the combination of P4KP and PcP that is reflected at the upper surface of the CMB is suitable for canceling the regional variations in the mantle and the crust because that the ray paths are very close to each other. Previously the differential travel times of P4KPPcP have been reported to be approximately 3 s larger than those from PREM using only Japanese seismic network, the J-array (Tanaka and Hamaguchi, 1996: Helffrich and Kaneshima, 2004). To confirm whether this observation is worldwide or regional, I have searched for good records around the world. Finally I find that the International Monitoring System (IMS) arrays provides high quality short-period P4KP data. To date, among more than 100 event-array pairs of which selection criteria are earthquakes with magnitude greater than or equal to 6.0 and focal depths greater than 100km, I have added 21 pairs that give clear PcP and P4KP phases to data from the J-array. New data include approximately pure meridian and equatorial paths. The arrival times of P4KP and PcP are picked by hand. The ray theoretical travel times of PcP and P4KP-AB are calculated with PREM as a reference. Those of P4KP-AB at distances beyond the cut-off point A are assumed to be a linear extension of the AB-branch. The resultant residuals obtained from the J-array and IMS arrays are scattered from +1 to +5 s. After correcting the travel times due to the ellipticity at the CMB for which the hydrostatic equilibrium are considered, the corrected P4KPPcP are distributed around 23 s. Thus it is still supported that the large positive residual is a worldwide feature. In order to explain the magnitude of the residuals, Tanaka and Hamaguchi (1996) and Helffrich and Kaneshima (2004) preferred SP6 (Morelli and Dziewonski, 1993). However, SmKS data exhibits that P-wave velocity in the outermost outer core of the SP6 is too slow (Garnero et al., 1993; Tanaka, 2007). Since the bounce points of PcP and piercing points of P4KP at the CMB are generally distributed on high-velocity anomaly regions at the base of the mantle, as revealed by global tomographic studies, and the residuals show a tendency to become small with increasing the epicentral distance, the P-wave velocity structure at the base of the mantle is unlikely for the explanation. Therefore the P4KPPcP residuals by 2 to 3 s should be explained by uniformly reduced P-wave velocity in the outer core by 0.05 to 0.1 % or excess core radius by 2 to 3 km comparing to those of PREM.

Keywords: seismology, core, p4kp

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

JAS001 **Oral Presentation** **287**

The dynamics of interacting compositional plumes

Prof. Ibrahim Eltayeb
Mathematics and statistics Sultan Qaboos University IAGA

M.A. Al-Lawati, T.B.A. Elbashir

Small scale motions in Earths outer core can influence the regeneration of the geodynamo if they can produce non-zero macroscopic helicity and alpha-effect. In an attempt to understand better the possible form and the interaction of such small scale motions, we study the dynamics of two compositional plumes rising in an infinite, thermally stably stratified fluid in the presence of a magnetic field and rotation. The stability of the mean state to infinitesimal disturbances is governed by the eight dimensionless parameters: the Prandtl number, , the magnetic Prandtl number, , the Reynolds number, R , the Taylor number, Ta , the Chandrasekhar number, Q, the ratio of the strengths of the two plumes, Gamma , x_0, x_1 and d the dimensionless measures of the thickness of the two plumes and the distance between them, respectively. The parameter R measures the strength of the compositional buoyancy. The mean flow and temperature depending on the coordinate normal to the parallel axes of the plumes are identified and the material, heat and buoyancy fluxes produced are investigated as functions of the parameters of the fluid including the thicknesses of the plumes and the distance between them. The stability of the mean flow is studied to determine whether such form of motions is possible i.e such motion is stable, or not. The stability results which are different from those of a single plume rising in the same fluid will be discussed and its dependence on the parameters relating to the fluid and the magnetic and rotation vectors as well as the resulting helicity and alpha-effect will be investigated.

Keywords: stability, compositional plumes, earth core

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

JAS001 **Oral Presentation** **288**

Synthetic Seismograms for realistic 3D Earth model with anisotropic inner core

Dr. Seiji Tsuboi
IFREE JAMSTEC IASPEI

Yoko Tono

We have demonstrated that we can calculate global theoretical seismograms for realistic 3D Earth models based upon the combination of a precise numerical technique (the spectral-element method) and a sufficiently fast supercomputer (the Earth Simulator) [Tsuboi et al, 2003]. Here we have calculated synthetic seismograms by using model S20RTS of the mantle (Ritsema et al., 1999), model CRUST2.0 of the crust (Basin et al., 2000), topography and bathymetry model ETOPO5, and anisotropic inner core model (Ishii 2002). The calculations are performed on 4056 processors, which require 507 out of 640 nodes of the Earth Simulator. These synthetics are computed by using SPECFEM3D(Komatitsch and Tromp, 2002) and are accurate up to 3.5 seconds. We have calculated these synthetics with aisotropic inner core model for several deep earthquakes and compared with the synthetics which are calculated for isotropic inner core model. Preliminary comparison shows that the travel time differences between anisotropic inner core model and isotropic core model for PKPab phases are at most a few seconds. There seems to be no significant differences in waveforms of PKP phases. These differences in travel times may help us to improve inner core fine structure by comparing these synthetics with observation.

Keywords: anisotropy, sem, earthsimulator

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

JAS001 **Oral Presentation** **289**

ExoMars/GEP Lander Radioscience LaRa, a Space Geodesy Experiment to Mars

Prof. Veronique Dehant
Time, Earth Rotation, and Space Geodesy Royal Observatory of Belgium IAG

Veronique Dehant, William Folkner, Sebastien Le Maistre, Danniel Orban, Martin Paetzold, And The Lara Team

The LaRa experiment is designed to obtain coherent two-way Doppler measurements from the radio link between the ExoMars lander and the Earth over at least one Martian year. These Doppler measurements will be used to obtain Mars orientation and rotation in space (precession, nutations, and length-of-day variations) as well as polar motion. The ultimate objectives are to obtain information on Mars interior (the core in particular) and on the sublimation/condensation cycle of atmospheric CO_2. The rotation variations will allow estimating the moment of inertia of the whole planet that includes the mantle and the core, the moment of inertia of the core, as well as the seasonal mass transfer between the atmosphere and ice caps. The LaRa experiment will be used jointly with the other experiments of GEP in order to obtain the maximum amount of information about the interior of Mars and consequently about its formation and evolution. The LaRa instrument consists of a coherent transponder using up- and downlinks at X-band frequencies. The signals are being generated and received by the DSN deep space network as well as by the ESA tracking stations. We will describe the experiment and discuss also important aspects of the data analysis, which will use dedicated software developed for the determination of the variations in lander position relative to the Earth as a function of time.

Keywords: mars, nutation, core

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

JAS001 **Oral Presentation** **290**

Experimental study of the migration of silicate, metal and sulfide phases in centrifugal fields.

Prof. Evgeny Lebedev
V.I.Vernadsky Institute of Geochemistry Russian Academy of Sciences IAGA

Simulation of the migration and accumulation of iron-sulfide phases under gravity, with the partial fusion of a model substance was carried out in a high-temperature centrifuge at 1400-1450oC under normal pressure*. The separation and motion of sulfides in the intercrystalline space is shown to be in an intimate relationship with the degree of a partial melting of a silicate matrix. As objects of the study, we used a sample with next three compositions: 85 wt.%Ol, 10 wt.%Bas, 5 wt.% FeS (95 wt.% Fe and 5 wt.%S). Experiments were carried out in a high-temperature centrifuge at 1400-1450oC under normal pressure at rotation rates of 3000 -- 6000 revolutions per minute, i.e. the Earth's gravitational field was surpassed by 2000-4000 times. The goal of this investigation was to study the influence of the oxygen fugacity, electrocapillarity effects, silicate matrix deformation on metal segregation in centrifugal fields. Experimental results show, that mixture consisting of olivine crystals, silicate and iron-sulfide melts, after being separated in a centrifuge, is differentiated in density at lg fO2 , some low IW at 1450oC. The study was supported by the RFBR No 07-05-00630 and PBR of Pr. RAS No 18. *E.B.Lebedev, A.A.Kadik, E.M.Galimov. Segregation of molten metal through partially molten silicate: simulation using a high temperature centrifuge. 32nd IGC - Florence, 2004; “T06.02

Keywords: ironcentrifugeacc

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

JAS001 **Oral Presentation** **291**

On the Expression of the 41,000 year in the Paleomagnetic Record of the Geomagnetic Field.

Dr. Mike Fuller
HIGP-SOEST U. Hawaii IAGA

Several authors have suggested that there is expression of the obliquity period in the paleomagnetic record, implying a role for precession in driving the dynamo. However, the observation remains controversial. The power at 41,000 years is only weak. Yet, it does appear that (1) excursions and major intensity lows are associated with minima in the obliquity signal during the last 800 kyrs (2) the distribution of the length of events less than 100,000 years peaks at 30 40,000 years. i.e. a little shorter than the obliquity cycle (3) reversals preferentially occur when the amplitude of the obliquity signal is low in the past 5 Myrs. (4) reversals occur preferentially within the obliquity cycle close to the point of inflection in the decrease from the maximum value. These observations have been rexamined using additional data, which extend the time scale of the tests. Particular emphasis is placed on the phase relationship of the obliquity cycle and the onset of reversals and excursions. The results are consistent with the earlier suggestion that there is expression of the 41,000yr obliquity cycle in the paleomagnetic record. Thus precession may play a role in driving the dynamo. However, possible relative motion between core and mantle due to changes in surface mass distribution, which are caused by climatic changes, may also occur. Preliminary results indicate that for the last 800 Kyr there is no strong systematic relationship between magnetic intensity lows and the del 18 O record, or ice record.

Keywords: precession, dynamo, paleomagnetism

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

JAS001 **Oral Presentation** **292**

Convection and magnetic stability of the planetary cores

Prof. Sergey Starchenko
Main geomagnetic field IZMIRAN IAGA

Planetary convection and magnetic instabilities driven by thermal or/and compositional power are investigated in their natural limit of very small transport coefficients. For the Earths type planets, the strong influence of the inner rigid core size is found on such double diffusion convection instability. The relative size about half of the modern Earths inner core size makes compositional convection valuable and able on addition magnetic support as in the past Earth or on magnetic appearance possible in future Venus. The inner core growing up to the about half of the convective shell size supports thermal convection and related magnetism. Further growing of the core suppresses the compositional convection which died out when thickness of the shell becomes too small. The last possibly was in the past Mars when its magnetic dynamo has been stopped. The principal balance between Magnetic, Archimedean and Coriolis force is in the Earth, Jupiter and Saturn with strong magnetic field in their cores. In Uranus, Neptune and perhaps Ganymede, magneto-convection is supported by the balance between Inertia, Archimedean and Coriolis forces those exceed or are about the magnetic force.

Keywords: convection, stability, magnetism

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

JAS001 **Oral Presentation** **293**

Translational oscillations of cores of Mercury, Venus, Mars and the Earth and variations of natural processes

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

Many from celestial bodies (planets, satellites and stars) can be considered as definite system of gravitating celestial bodies - the system of shells. From these shells the mantle and the core are basic. Shells are non-spherical, inhomogeneous, non-balanced bodies and, generally speaking, are characterized by eccentric relative positions. Hence, they are exposed to various gravitational actions on the part of external celestial bodies. In result the core and the mantle are forced to make small relative translational displacements, turns and to be deformed with frequencies, characteristic for external influences (Barkin, 2002). Free oscillations of the core-mantle system are perturbated also (Barkin, 2005). The mentioned oscillations of the Earth system have been studied by us on a basis of simple base model of the Earth in which the core is considered as an unchangeable rigid spherical body (or as a liquid body), and the mantle - as an elastic body. At studying of the forced oscillations the core and the mantle are considered as eccentric non-spherical bodies (separated by the thin viscous-elastic layer) which are subject to differential gravitational influence on the part of the Moon and the Sun (Barkin, 2001; Barkin, Vilke, 2004). Characteristic frequencies (periods) of the free and forced oscillations of the core and the mantle have been determined, their amplitudes have been evaluated. The differential action of the Sun on the displaced and non-spherical core of a planet inevitably causes its diurnal and semidiurnal oscillations relatively to the centre of mass of the elastic mantle. By virtue of a nonlinear character of the phenomenon a wide spectrum of oscillations (in particular with the periods multiple to solar day) is observed. Specified displacements lead to variations of the tension state of the mantle layers, to variations of tensor of inertia of a planet and, as consequence, to variations of its rotation. It is natural, that the mentioned changes will be shown in all planetary natural processes which will strictly correlated with each other. All told is confirmed by the geodynamic and geophysical studies of the Earth. Calculated values of periods of variations of natural processes make: (the Earth) 24.00; 12.00; 8.00; 6.00; 4.80; 4.00; 3.43; 3.00; 2.67; 2.41 (in hours). Variations with the mentioned periods and derivatives from them are observed in many geodynamic, geophysical, biological and physical processes that specifies an existence of the effective mechanism of excitation of oscillations. Relative displacements and turns of the core and the mantle result in dynamic influence on a planet as a whole, on all its shells, including an atmosphere, biosphere and noosphere, on states of its physical fields. Rhythms of influence - are uniform, as are set by the uniform central mechanism, and it is in reality confirmed by observations. The hour periods with a various degree of detailed elaboration are revealed in variations: rotations of the Earth, seismic noise, geoelectric parameters of rocks, decontamination of the Earth, a level of subsoil waters, vibration of an earth's crust etc. Similar variations of physical, chemical and biological processes were studied during many years by Simon Shnoll with co-authors (Shnoll et al., 1998). Mars has strongly eccentric the core (by our estimations the displacement of its centre of mass relatively to the centre of mass of a planet can make 20-25 km). The significant eccentricity has a position of the Venus core. Large formations of Mercury testify an high eccentricity of position of its core. Hence, by analogy to the Earth (for which the eccentricity in position of the core is estimated in 0.3 km) the elastic swing of core-mantle system of Mercury, Venus and Mars should result in variations of their planetary processes with the following periods: (Mercury) 175,94; 87.97; 58.65; 43.99; 35.19; 29.32; 25.13; 21.99; 19.55 (in days), (Venus) 116.75; 58.38; 38.92; 29.19; 23.35; 19.46; 16.68; 14.59; 12.97; 11.68 (in days), (Mars) 24.66; 12.33; 8.22; 6.17; 4.93; 4.11; 3.52; 3.08; 2.74; 2.47 (in hours). The obtained periods will be observed in variations of rotary motion of the specified

celestial bodies, in variations of their magnetic and other physical fields, in variations of atmospheric processes, in them inversion displays in opposite hemispheres, in variations of a gravity, in variations of seismicity etc. Referenses 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. Barkin Yu.V. (2005) Oscillations of the Earth core, new oceanic tides and dynamical consequences. Materials of XI International Scientific Conference "Structure, geodynamics and mineral genetic processes in lithosphere" (September, 20-22 2005, Syktyvkar, Russia), Publisher of Geology Institute of Komi SC of Ural Section of RAS, Syktyvkar, pp. 26-28. In Russian. Shnoll S. E., Kolombet V.A., Pozharskii E.V., Zenchenko T.A., Zvereva I.M., Konradov A.A. (1998) About realization of discrete states of fluctuations in macroscopic processes. Advances of physical sciences, 168, N 10, October 1998, pp. 1129-1140.

Keywords: mars, mercury, venus

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

JAS001 **Oral Presentation** **294**

Texture of Earths Uppermost Inner Core from Forward and Back Scattered Seismic Waves

Prof. Vernon Cormier
Physics Department University of Connecticut IASPEI

Body waves interacting with the boundary of the solid inner core at narrow and wide angles of incidence provide independent constraints on a heterogeneous texture that may originate from the process of solidification. The equatorial, quasi-eastern hemisphere, of the uppermost 50-100 km of the inner core is characterized by a higher isotropic P wave velocity, higher attenuation inferred from PKIKP, and simpler PKiKP pulses compared to adjacent regions in the western hemisphere and polar latitudes. Compared to this region, the adjacent western (primarily Pacific) equatorial region is characterized by lower attenuation and a higher level of coda excitation following PKiKP. Lateral variations in both inner core attenuation inferred from transmitted PKIKP and inner core heterogeneity inferred from the coda of reflected PKiKP can be modeled by lateral variations in a solidification fabric. In an actively crystallizing eastern equatorial region, characterized by upwelling flow in the outer core, fabrics that explain strong attenuation and the absence of attenuation and velocity anisotropy in short range PKIKP and weak PKiKP codas have an anisotropy of scale lengths with longer scale lengths in the vertical direction, perpendicular to the inner core boundary. In less actively solidifying regions in the equatorial western hemisphere, longer scale lengths tend to be more parallel to the inner core boundary, consistent with outer core flow tangent to the inner core boundary or viscous shearing and recrystallization in the horizontal direction away from more actively crystallizing regions in the eastern hemisphere. This texture is less effective in attenuating PKIKP by forward-scattering. Lateral variation in the equatorial western hemisphere between vertical versus horizontal oriented plate-like textures may explain lateral variations from weak to strongly back-scattered PKiKP coda and from strong to weak velocity and attenuation anisotropy in short range PKIKP.

Keywords: inner core, outer core, scattering

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

JAS001 **Oral Presentation** **295**

Marginal stability of almost adiabatic convection in rotating planetary shells

Mr. Igor Maslov
Department of physical hydrodynamics Lavrentyev Institute of Hydrodynamics SB RAS IAGA

Maria Kotelnikova

The problem of thermal convective instabilities of a fluid in rotating self-gravitating spheres and shells has been subject of many papers mostly due to its importance for various geophysical and astrophysical applications. The fluid motion inside the Earths outer core is examples of the flows for which knowledge on the general behaviour of such convection can be applied. In most of the works on this issue the Boussinesq fluid is considered. However, it is known that almost adiabatic states are typical for the deep convective interiors of all known planets and their moons. The asymptotic theory for the marginal stability of almost adiabatic geo-convection was given just recently by Starchenko et al. (Geophys. Astrophys. Fluid Dynam. 2006. V. 100). Asymptotic analysis was performed within the framework of local theory and new estimates of critical parameters differ from those obtained previously using the Boussinesq model. Here we consider the marginal stability of well-mixed almost adiabatic states in rapidly rotating thick spherical shells, whose inner to outer radius ratio does not exceed that of the modern Earth. The critical Rayleigh-type numbers, frequencies and solution structures of the marginal states are determined by both analytical and numerical methods. To determine critical parameters analytically we use global WKBJ theory developed by Jones et al. (J. Fluid. Mech. 2000. V. 405). Parameters for the marginal stability of an almost adiabatic convection for Pr=1, Pr<<1, and Pr>>1 are found. In each case we consider the range of inner to outer radius ratio and different combinations of values of inner and outer heat fluxes. We undertook the corresponding numerical simulation and our analytic predictions compare favourably with it. Time-dependent instabilities are studied for a range of the Rayleigh-type number, for values of the Ekman number down to 10-5. This work was supported by INTAS-03-51-5807 grant.

Keywords: adiabatic, convection, instabilities

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

JAS001 **Oral Presentation** **296**

Recent progress on core dynamics from magnetic observations

Dr. Chris Finlay
Division V ETH Zurich, Switzerland IAGA

This talk will review recent progress in our understanding of core dynamics using observations of the geomagnetic field from satellites, magnetic observatories, historical surveys, maritime records and archaeo and palaeomagnetic sources. Observed patterns of magnetic field change at the core surface over the past four centuries will first be described. The possible origin of high amplitude, wave-like patterns of field evolution at low latitudes will be discussed. High resolution images of the core surface field from satellite data will be described and the characteristics of a possible geomagnetic jerk in 2003 will be detailed. The current state of the art in the determination of core motions from secular variation observations will be reviewed. The results of tests on geodynamo models will be described and difficulties in inverting for wave motions will be mentioned. New proposals for quasi-geostrophic inversions and progress in our understanding of core-mantle coupling will also be reviewed. Finally, recent advances in our understanding of core motions on longer timescales using archaeo and palaeomagnetic data will be discussed. Evidence for both eastward and westward motions at mid-latitudes in the CALS7K.2 model over the past 3000 years will be presented and efforts to determine the core surface field evolution during the last geomagnetic reversal will be summarised.

Keywords: geomagnetic secular variation, core dynamics, magnetic field observations

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

JAS001 **Oral Presentation** **297**

Torsional oscillations and the viscosity of the Earth's core

Dr. Jon Mound
School of Earth and Environment University of Leeds IAGA

Bruce Buffett

Viscous effects are generally neglected in theoretical studies of torsional oscillations due to the presumed low value of viscosity (order 10^{-6} m^2/s) for the Earth's fluid core. This value of viscosity is extrapolated from studies of liquid metals under laboratory conditions; however, recent nutation studies have suggested that the viscosity may be as large as 10^{-2} m^2/s, perhaps due to turbulent effects. Torsional oscillations act on very different time and length scales than nutations and may provide an independent constraint on the effective viscosity of the fluid core. In this study we incorporate viscous effects in to the theory of torsional oscillations normal modes. Dissipation due to viscous damping increases the periods and shortens the decay times of the normal modes; for a sufficiently large viscosity the existence of freely oscillating normal modes is precluded. Observations of torsional oscillations suggest that decadal period modes have decay times of nearly one hundred years. We find that the existence of free torsional oscillation normal modes places an upper bound on fluid viscosity of o{10^0} m^2/s. If we take the stricter constraint that the normal modes match the observationally inferred decay times, then the upper bound is lowered to o{10^{-2}} m^2/s. A significantly lower viscosity is not precluded by our results as electromagnetic coupling at the CMB may be a significant source of dissipation in the physical system.

Keywords: viscosity, torsional oscillations, core

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

JAS001 **Oral Presentation** **298**

Zonal flows in planetary cores: The effect of rotation

Dr. Martha Evonuk
Institut fuer Geophysik ETH Zuerich

Two-dimensional (2D) computer simulations of thermal convection in the equatorial plane of density-stratified planets without solid inner cores explore the relationship between thermal forcing and the number of zonal jets established in radius. Differential rotation in these 2D simulations is maintained by the convergence of the non-linear Reynolds stresses from vorticity generated as the fluid moves radially through the density stratification. Increasing the rotation rate and decreasing the thermal forcing can lead to multiple jet structure without relying on boundary interactions with columnar structures that span the core. This could be an important source of zonal flow in highly turbulent systems that are unable to support Taylor columns.

Keywords: planetary, convection

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

JAS001 **Oral Presentation** **299**

Characteristic parameters of geomagnetic jerks related to mantle conductivity

Dr. Hiromichi Nagao
IFREE JAMSTEC IAGA

Hisayoshi Shimizu, Hisashi Utada

The geomagnetic jerks, which are observed in worldwide in 1969, 1978, 1991, and possibly 1999, are known to be the shortest time scale phenomena of core origin appeared on the Earths surface. The jerks are considered to be affected by the conductive lower mantle, therefore our eventual goal is to clarify the 3-D deep mantle conductivity structure by investigating the jerks. Backus [1983] derived theoretically, in each spherical harmonic degree, characteristic parameters of the jerks (amplitude, delay time, and smoothing time) related to the mantle conductivity, assuming that a jerk is input from the core-mantle boundary (CMB) to a 1-D conductive mantle. We have been developing a tool using the Kalman filter that enables us to determine objectively and automatically these characteristic parameters of the jerks. The time series model in our tool consists of four components; trend, seasonal, autoregressive, and noise components. The trend component is assumed to be a convolution of a second order spline function and a normal distribution function in accordance with the Backus theorem. The seasonal and autoregressive components, which correspond respectively to annual variation and solar cycle effect, are determined at the same time with the trend component. The error level in each optimized parameter can be estimated by the Jackknife method. We obtain a spatial distribution of each characteristic parameter for the 1969 and 1978 jerks by applying this tool to monthly means of the eastward component. For example, it is found that the amplitude of each jerk distributes with a spherical harmonic component of (2, 2), and this spatial structure implies the distribution of magnetic field related to the jerks at the CMB and/or the mantle conductivity heterogeneity. It should be noticed that we can determine only the characteristic parameters of an apparent mantle filter, which is a linear summation of mantle filters in all degrees; it is difficult to determine the characteristic parameter in each degree from real geomagnetic data. Therefore we will carry out a forward modeling of how a jerk input from the CMB propagates in a conductive mantle, and propose an optimized mantle conductivity model that can explain the spatial distributions of the characteristic parameters obtained by data analyses including the northward and vertical components. We will report an initial result of the forward modeling in the presentation.

Keywords: geomagnetic jerk, kalman filter, mantle conductivity

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

JAS001 **Oral Presentation** **300**

Coupling of lowermost mantle and uppermost inner core by convection in the Earth's outer core

Dr. Julien Aubert
Laboratoire de Dynamique des Fluides Gologiques Institut de Physique du Globe de Paris

Hagay Amit, Peter Olson, Gauthier Hulot

The Earth's inner core is a layered and heterogeneous medium. In addition to the seismic velocity difference between polar and equatorial ray paths, which is thought to be a property of the bulk inner core, recent studies highlighted differences in seismic velocity, attenuation, and waveform between the Eastern hemisphere (40E-180E) and the western hemisphere (180W-40E), which are attributed to the top 100 km of the inner core. Using numerical models of core dynamics, we explore the possibility that this lateral heterogeneity may be due to coupling with an heterogeneous core-mantle boundary, through fluid dynamics in the outer core. We solve for thermo-chemical Boussinesq convection and self-sustained dynamo action in a rotating spherical shell. At the outer boundary we impose zero flux of light elements, and a constant heterogeneous heat flux pattern derived from lower mantle seismic tomography. At the inner core boundary a constant co-density boundary condition allows us to treat the inner core as a reservoir of latent heat and light elements responding to outer core dynamics through a spatially and temporally variable buoyancy flux. Owing to a large disparity of time scales, the inner core growth is mostly sensitive to the time-average behavior of outer core dynamics, particularly the dynamical perturbation in the outer core induced by core-mantle boundary heterogeneity. A simple proportionality between the local inner core growth rate and buoyancy flux results in a hemispherical growth rate pattern that matches the seismic observations. This pattern is mostly due to a downwelling originating at the core-mantle-boundary below China. We discuss possible links between our results, seismic observations, recent crystallization experiments, and possible differential rotation of the inner core.

Keywords: core mantle boundary, inner core boundary, coupling

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

JAS001 **Oral Presentation** **301**

Topographic core-mantle coupling and subdecadal variations of the core flow

Dr. Seiki Asari
Section 2.3 Earth's Magnetic Field GeoForschungsZentrum Potsdam IAGA

Hisayoshi Shimizu, Hisashi Utada

It has been reported from observations that the geomagnetic jerks have occurred in concurrence with characteristic variations of the Earth rotation, in both the length-of-day (LOD) variation and polar motion. These events may originate in common phenomena within the Earths fluid core, with their timescales as short as a year (referred to as short-term here). In this study we remark the topographic core-mantle coupling as a possible dynamical process relevant to the observed short-term events, and demonstrate its potential to drive short-term accelerations of the core fluid. Theory suggests that reaction of the core fluid to driving forces on yearly timescales is represented particularly by an acceleration of rotation of rigid annulus that is coaxial with the Earths rotation axis and hence responsible for fluctuations of the axial core angular momentum. We formulate the axial topographic torque on the annulus by describing it in terms of the core-mantle boundary (CMB) topography and meridional core surface flow. This is based on an expectation that axial angular momentum should be transferred across the CMB by far more efficiently through interaction of the topography with meridional surface flow than azumuthal flow. We then estimate time-series core surface flow models explaining the geomagnetic model ufm1 (1840-1990) as well as LOD data by way of the net topographic torque on the mantle. A CMB topography model inferred from seismology (with typical amplitude of several km) is employed for calculating the torque. These models of flow and topography are used to compute time-series topographic torque on the annulus. Relevance of the topographic coupling to short-term flow accelerations is assessed by comparing the topographic torque on each core annulus with the inertial torque (i.e. acceleration of annulus rotation) with reference to their time variability and amplitude. We find that one can even obtain a flow model that achieves a good agreement between short-term fluctuations of the topographic and inertial torques on every annulus, if constrained so, with little reduction of fit to the observations. In light of inversion problem such a flow model owes the agreement merely to the given formalism of the topographic torque which is highly sensitive to the flow distribution. A physical support can be provided, nevertheless, by an estimate of the spin-up time due to the topographic coupling: ~1 year (derived assuming ~10-3 for the ratio of the CMB topography amplitude to the core radius). The present analysis implies that a small time variation of the non-axisymmetric core flows, which are thought to be relatively stable in time, can lead to an effective excitation of the torsional oscillations, and also it may explain the observed short-term events that are rather irregular in their occurrence times.

Keywords: core flow, core dynamics, core mantle coupling

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

JAS001 **Oral Presentation** **302**

The effect of the inner core dimension on the termination of Martian Dynamo

Dr. Weiyuan Jiang
Joint Center for Earth Systems Technology University of Maryland at Baltimore County

Weijia Kuang

It is well accepted that Mars used to possess an active dynamo in its early evolution history. Remnant magnetism measured from the Mars Global Surveyor (MSG) indicates that Martian dynamo is very likely a strong field dynamo before its termination. Thus termination of Martian dynamo is a unique problem and deserves special attention. In particular, Martian dynamo can be sub-critical before termination, since a strong magnetic field can help offset the Taylors constraint from the Coriolis effect. Consequently, it can be maintained by an energy budget lower than that for the onset of dynamo action in the Mars core. Understanding the nature of the Martian dynamo before its termination is very important for several reasons. For example, it could provide better estimation of the buoyancy force for the dynamo, and it could verify and be verified how whether the termination occurred over a very short time period. In the past years, we have carried out a series of numerical dynamo simulations with our MoSST core dynamics model, in which the inner core radius is approximately 1/3 of the core radius. Our results show that, when the Rayleigh number (the parameter measuring the buoyancy force) is reduced from a very large value, the magnetic field strength is comparable for a large parameter range. As the Rayleigh number is further reduced, it decreases very rapidly: the field strength is reduced by 2 orders of magnitude in less than 1% reduction of the Rayleigh number. In particular, this reduction occurs at the Rayleigh number 20% lower than that required for the onset of the dynamo, a clear evidence of a sub-critical strong field dynamo. However, for better understanding the termination of the Martian dynamo, we need to investigate whether the subcritical dynamo still exists for different parameters of the system. In particular, we are interested in examining the effect of the inner core dimension on the subcritical dynamo, since it is determined by the thermal evolution of the planet.

Keywords: dynamo

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

JAS001 **Oral Presentation** **303**

Geometrical and thermal effects of the inner core on magnetohydrodynamic dynamos

Dr. Yusuke Oishi
Department of Earth and Planetary Science Univerity of Tokyo

Ataru Sakuraba, Yozo Hamano

The Earths inner core accounts for only 4 % of the total volume of the core, but still has significant effects on the geodynamo. The existence of the solid inner core gives a geometrical boundary condition to the fluid motion. When the Coriolis force is much stronger than the viscous and inertial forces, as is the case of the Earth, a non-axisymmetric flow becomes singular at the inner core tangent cylinder without appropriate external forces, which could produce a unique flow structure along the cylindrical surface (Hollerbach, Phys. Fluids, 1994). In general, the dynamo actions inside and outside the tangent cylinder are qualitatively different (Takahashi et al., PEPI, 2003). The inner core also puts a thermodynamic boundary condition in a thermally driven geodynamo model. For example, solidification of the inner core produces latent heat, which could be an important energy source as well as cooling of the core (Buffett et al., JGR, 1996). These effects must be functions of the size of the inner core. Therefore, it is worth examining how the dynamo action changes with the changes of the geometrical and thermal conditions. We performed systematic numerical simulations by changing the size of the inner core and the heat source parameter, Q, which is defined by the ratio of heat input on the inner core boundary (ICB) to the total heat output to the mantle. In some recent high-resolution geodynamo simulations (e.g. Takahashi et al., Science, 2005; Christensen and Aubert, GJI, 2006), convection is driven only by heat input at the inner core surface (Q = 1 in our definition). However, it might be an inappropriate condition because, in such a situation, heat flow per unit area of the ICB is nearly ten times greater than that at the core-mantle boundary (CMB), which means the flow near the ICB is unnaturally vigorous. Although the effects of the inner core have been already studied to some extent (e.g. Sakuraba and Kono, PEPI, 1999; Kutzner and Christensen, PEPI, 2002), we aim to elucidate them in a more Earth-like condition, where viscosity is negligible and the inertial force is much smaller than the Lorentz force. The numerical model is almost the same as Sakuraba and Kono (1999) but the Ekman number is now 10^{-5}, the thermal and magnetic Prandtl numbers are 1, and the Rayleigh number (Ra) is increased up to 50 times critical. We compared the results with and without the inner core, and the results of Q = 0, 0.5 and 1, if the inner core exists. We neglected the electrical conductivity of the inner core, but partially took into account its finite heat capacity. Some of the conclusions of this study are as follows: (1) We confirmed the low-, moderate-, and high-Rayleigh-number regimes irrespective of the geometrical and thermal conditions. In the low- and moderate-Ra regimes, quasi-stable dipolar magnetic fields are generated, while the magnetic field is highly time-dependent in the high-Ra regime. (2) The magnetic field intensity outside the core seems to be determined by the total heat flow at the CMB. (3) The tilt of the dipole axis decreases with the increase of Ra in the moderate-Ra regime. The tilt is smaller in the case of no inner core. (4) The transition from the moderate- to the high-Ra regimes coincides with the excess of the kinetic energy density over the magnetic one in the fluid. With the total heat flow being fixed, the ratio of the kinetic to magnetic energy density tends to increase with the increase of Q. Therefore, it can be said that addition of heat sources at the ICB makes the dynamo more unstable.

Keywords: geomagnetic field, inner core, geodynamo

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

JAS001 **Oral Presentation** **304**

Turbulent thermal convection in liquid metal and the effect of magnetic field

Dr. Takatoshi Yanagisawa
IFREE JAMSTEC IAGA

Yasuko Yamagishi, Ataru Sakuraba, Yuji Tasaka, Kanako Yano, Yasushi Takeda, Yozo Hamano

The convective flow in the outer core is supposed to be extremely turbulent, because molten iron has very low viscosity and the spatial scale is large. It is important for the outer core dynamics that the flow behaves turbulent under the influence of rotation and magnetic field. But it is very difficult to directly simulate the turbulent flow in the outer core numerically in MHD calculation. It is generally recognized that three-dimensional numerical simulations have unveiled the dynamics of the core to some extent. The problem is that viscosity and angular velocity in present numerical models never correspond to the realistic values of the core at the same time; the results are only obtained of sticky fluids or in the case of a planet rotating no more than once a year. There is no adequate grounds that the simulation results can be directly applied to hydrodynamic and electromagnetic phenomena in the core. On the other hand, laboratory experiment is a useful way for studying highly turbulent flow, though the size is too small to realize self-sustained dynamo motion. Here we show the results of laboratory experiment on turbulent thermal convection, and compare them with numerical simulations under similar physical conditions. Our purpose is to obtain fundamental data of turbulence applicable to the Earth's core. To visualize flow structure and its fluctuation is a desired way for understanding any type of flow. Liquid metals are opaque fluids, so optical methods for the flow measurement cannot be applied. We improved the Ultrasonic Velocity Profiler method to measure the fine-scale velocity field of the flow occurring in the liquid metals. The principle of this method is as follow. A series of ultrasonic pulse emitted from an ultrasonic transducer is reflected by the particles suspended in fluid, and is received by the same transducer. Position information is given by the time of flight from emission to reception of the ultrasonic pulse, and velocity information is obtained by analyzing the Doppler shift of the received echo signal. If the number density of the particles is enough, ultrasonic pulse is reflected everywhere on the passing line of the pulse. Thus, this method can measure an instantaneous velocity profile along the line. By scanning the measurement lines, we can visualize the whole flow pattern existing in the tank. We succeeded in the direct measurement of velocity profile for the Rayleigh-Benard convection in liquid gallium, with and without uniform magnetic field. The geometry of the tank is rectangular one, and the system is not rotating. Measuring the horizontal velocity at several sites in the tank, many fluctuations are observed, that reflect turbulent behaviors of the flow. When we see the long-term tendency, we can reconstruct two-dimensional roll-like pattern. This roll-like pattern is supposed to be a kind of mean-flow which is the organized structure in the turbulence, and the small fluctuations may show the behavior of small plumes. The roll-like pattern shows clearly regular periodic behavior. This means that the roll structure gets longer and shorter laterally and periodically. When we apply horizontal magnetic field along the roll axis of this convecting system, the fluctuating components are reduced remarkably and the mean velocity of the roll-like flow pattern is increased. The lateral movement of the rolls decreases with the magnetic field, but the typical frequency of this periodic behavior is unchanged. We obtain a series of numerical results of thermal convection for comparison to the laboratory experimental data. Our numerical result reproduces oscillatory convection patterns as observed in the experiments. We report the results of systematic study on the nature of turbulence by varying Prandtl number and magnetic-Prandtl number in this numerical simulation.

Keywords: convection, turbulence, magnetic field

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

JAS001 **Oral Presentation** **305**

The Role of Resonant Triads in Driving Planetary Dynamos

Prof. Keith Aldridge
Graduate Program in Earth and Space Science York University IAGA

Ross Baker, David Mcmillan

We present evidence that externally imposed strains on planetary cores can produce large scale parametric instabilities capable of powering the dynamo needed to maintain a planetary magnetic field. Results of laboratory experiments and analysis of records of relative paleointensity are shown to support the existence of parametric instabilities in Earths core. Strains are produced by the gradient of the Luni-Solar gravity field in Earths fluid core. A resonant triad results when these strains couple pairs of inertial modes of the core. Instability will result as long as its rate of growth which is proportional to the Luni-Solar strain, exceeds its rate of decay. Laboratory experiments to excite parametric instabilities in a rotating fluid contained by flexible walls have shown that these instabilities exist both with and without a solid inner core. Accordingly, a dynamo maintained by instabilities produced by the Luni-Solar gradient would continue to run throughout the growth of Earths solid inner core. A search has been made of relative paleointensity measurements on Earth for the signature of a parametric instability. We report the results of new analysis for both composite and single cores covering the North and South Atlantic Ocean as well as the West Caroline basin in the Pacific Ocean. Measured ideal growth rates are consistent with those calculated for the Luni-Solar gradient. Calculated rates, based on linear stability theory, are smaller than measured values which is consistent with laboratory observations of parametric instabilities.

Keywords: parametric, instability, paleointensity

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

JAS001 **Oral Presentation** **306**

Effects of Si on the crystal structure and elastic property of Fe at Earths inner core pressures

Prof. Taku Tsuchiya
Geodynamics Research Center Ehime University

Mika Fujibuchi

Earths inner core is generally thought to consist of Fe-Ni alloy. Some amount of light element are also maybe contained in the inner core. Recent high-pressure experiments and theoretical simulations have suggested that Si is a highly possible candidate of impurity elements in the inner core. In this study we investigated the effects of Si on the crystal structure and elastic property of iron at the Earths inner core pressures by first-principle calculations to clarify the acceptability of Si as an inner core constituent. Calculated results showed Si having large effects to change the elasticity of the hcp phase of iron at the inner core P,T condition. We will report the Si contents for several iron phases needed to reproduce the observed inner core elasticity.Research supported by the Ehime Univ Project Fund.

Keywords: iron silicide, elasticity, first principles method

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

JAS001 **Oral Presentation** **307**

Observational constraints on core structure and core chemistry

Prof. George Helffrich
University of Bristol Earth Sciences Department IASPEI

James Wookey, Oliver Lord, Mike Walter

The long view downward into the Earths core is sharpening from new sources of data. Increasingly, core seismologists use the seismic arrays deployed for monitoring the Comprehensive Test-Ban Treaty, for hazard assessment, and for fundamental research into continental structure to improve knowledge of the core. This is bringing into view much broader areas of the core and allowing some areas of it to be more finely probed than before. We review some major results from these studies and assess the areas of ignorance about the cores structure and where further knowledge might lead..The focus of core studies used to be the inner core. In the past decade, the inner cores anisotropy was documented, as well as the curious quasi-hemispheric variation in wavespeed. Radial variation in the strength of the inner cores anisotropy was found along with a hemispheric variation in the boundary between the outer isotropic part and the inner anisotropic part. Newer data subsequently yielded an observation of splitting in the inner core S-waves of about 1% anisotropy. Newer data also suggest that the high-frequency reflection coefficient at the inner core boundary entails density jumps of around 0.5 g/cm3 as compared to 0.8 g/cm3 by free oscillation analyses, and a suggestion of lateral variation of that coefficient across the inner core boundary. The fine-scale structure of the inner core, inferred from the scattering of high-frequency P waves, appears to vary laterally. These details reveal complexity in the inner cores structure that are not yet fully understood by compositional or growth models of the inner core..New details of outer core structure are emerging from the newly-available data as well. This seemingly featureless area potentially contains key information for geodynamo energetics and the overall composition of the outer core that is seismically observable. In models of core chemistry and dynamo power sources, radial variations in composition are possible at the bottom of and at the top of the outer core. Recent studies of multiply-reflected outer core arrivals and of differential travel times between pairs of waves that cross the outer core show evidence for radial structure near the outer cores boundaries but limit the layering possible there. There are unlikely to be layers of separate liquids, but compositional stratification in the liquid is possible. The differential travel times suggest it may be present at either of the outer cores boundaries..The seismological observations constrain core chemistry in two ways. One way is through the properties of the inner core. Its anisotropy limits the permissible crystal structures, and thus the composition of the inner core. The other seismological constraints on core chemistry arise from the absence of observable layering in the cores liquid. Many of the iron alloys that might reduce the cores density form two liquids when they melt at low pressures. Provided that this behavior continues to core conditions, the absence of strong evidence for a two-liquid core constitutes a usable constraint on core chemistry. These ideas, motivated by these new sources of seismological data, are stimulating work in computational mineral physics, experimental petrology and in core structure.

Keywords: core, seismology

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

JAS001 **Oral Presentation** **308**

A search for Slichter mode using extensometer records in Japan due to the 2004 Great Sumatra earthquake

Prof. Ichiro Kawasaki
Disaster Prevention Research Institute Kyoto University IASPEI

Azumi Komaki, Wataru Morii, Yuzo Ishikawa, Tsuneya Tsubokawa, Makoto Okubo

We have three excellent extensometers at Matsushiro (JMA), Mizusawa (NAO), Amagase (Kyoto Univ.) and a borehole strainmeter at Byobusan (TRIES) in Japan. At the time of the 2004 Great Andaman-Sumatra earthquake of Mw9.0 (Harvard CMT Catalogue), the extensometers and the borehole strainmeter recorded extraordinary signals of predominant periods of hundreds to thousands of seconds. We calculate running spectra of 6 day length with a mutual time lag of 1 hour, corrected for the Earth's tide and the atmospheric pressure effect, to find three decaying spectral peaks at frequencies of the Slichter mode (1S1) of around 0.046 mHz (6.0 h), 0.053 mHz (5.2 h) and 0.057 mHz (4.9 h) in the running spectra of only the extensometer records at Matsushiro with amplitude of 10-15 in strain2 s2, 1 order larger than that for PREM (Dziewonski and Anderson, 1982), although the eigenfrequencies are consistent with those (Dahlen and Tromp, 1998) for PREM but seems to be inconsistent with those (Dahlen and Sailor, 1979) for 1066A. Note that the eigenperiod of the Slichter mode is roughly proportional to the density contrast between the lowermost outer core and the uppermost inner core. No signals are found in spectra of extensometer records at Amagase (Kyoto Univ.) and at Byobusan (TRIES). Thus, the conclusion in this report is preliminary.

Keywords: slichter mode, extensometer, 2004 sumatra earthquake

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

JAS001 **Oral Presentation** **309**

Seismic constraints on inner core structure from normal mode data, and comparison with mineral physics

Dr. Arwen Deuss
Earth Sciences University of Cambridge IASPEI

The solidity of the Earth's inner core was inferred in 1971 from normal mode observations. However, since then there has been little further proof that the inner core is solid and observations of PKJKP body wave arrivals are strongly dependend on the assumed inner core shear wave velocity. Ab initio mineral physical calculations suggest seismic velocities for various candidate structures which conflict with seismological results.Here, we try to constrain the velocity structure of the inner core and show which, if any, models from mineral physics are compatible with the normal mode data excited by the 1994 Bolivian and 2004 Sumatran earthquakes. We aim to reinforce the argument for a solid core, and determine the most likely average velocity from this data. Synthetic spectra, calculated for models with varying compressional and shear wave velocity, are compared with seismic spectra. We find that the best fit is obtained for inner core velocities very close to the PREM reference model: vs = 3.55 +/- 0.05 km/s, vp = 11.15 +/- 0.1 km/s. Velocities for candidate iron structures at inner core conditions from ab initio calculations are shown to disagree with the data. In most cases the fit is worse than for a liquid inner core model, suggesting that many effects remain unaccounted for. The discrepancy can be explained by the existence of fluid inclusions in the inner core, or the effect of viscoelastic weakening as the inner core is close to its melting temperature.A layered inner core structure is also investigated and we find evidence for a discontinuity in velocity at a radius of 1020 +/- 40 km. Using fully coupled normal mode synthetics, we find support for an isotropic outer layer surrounding an anisotropic region of the inner core, possibly due to a change in mineral structure across this boundary.

Keywords: inner core, free oscillations

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

JAS001 **Oral Presentation** **310**

Inner core anisotropy investigated with normal modes and body waves

Mrs. Jessica Irving
Department of Earth Sciences University of Cambridge IASPEI

Dr Arwen Deuss

A number of previous studies have investigated the existence of seismic anisotropy in the Earth's inner core. This anisotropic nature has been modelled using free oscillation data with widely varying results, which are formally inconsistent with each other. All of these models derived from normal mode data have been developed using a self coupling approximation which ignores the significance of coupling of different inner core modes through the anisotropic structure. This self coupling approximation of normal modes is not reliable (Deuss & Woodhouse 2001), we have shown that this is also the case for the inner core. Body waves travelling through the inner core also show anisotropic behaviour; wave speed in the North-South direction is greater that in the equatorial plane. Other seismological features of the inner core have been proposed, including heterogeneous degree one structure and the presence of two seismically distinct layers. These properties of the inner core should be observable in normal mode spectra. At present there are inconsistencies between the body wave and normal mode data which must be resolved. By comparing body wave and normal mode data with inner core anisotropy models we hope to find a picture of inner core anisotropy that is consistent with the seismic observations. Such information is a prerequisite for the integration of results from seismology and mineral physics, with the aim of establishing the details and causes of inner core anisotropy.

Keywords: inner core, anisotropy, seismology

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

JAS001 **Oral Presentation** **311**

Recent progress in models of planetary interiors

Mr. Attilio Rivoldini
Time, Earth's rotation and Space Geodesy Royal Observatory of Belgium

Verhoeven Olivier, Mocquet Antoine, van Hoolst Tim, Dehant Veronique

Among all the available data provided by planetary missions missions, average density, moments of inertia and the tidal Love number k2 give the most significant constraints on the deep interior of planets. For instance, the recent determination of the Love number k2 of Mars indicates that the core is partially liquid.We review the interpretation of the geodetic data in terms of interior quantities such as the size and composition of the core and the mantle viscosity and discuss the implications on models of the bulk composition and thermal state of the planet. The interior modeling requires data on physical characteristics of the core assemblage and of the mineralogical components of the mantle. In particular, we use new data on liquid iron-sulfur and discuss the possible presence of a solid inner-core for different melting laws. We investigate the consequences of the global dissipation factor Q on the rheology of the Martian mantle.Finally we apply the above considerations to Mercury and discuss the resulting constraints on its interior structure from the expected data of the forthcoming space missions.

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

JAS001 **Oral Presentation** **312**

Uncertainty in seismological parameters within the core

Dr. Bernard Valette
LGIT Universit de Savoie, IRD IASPEI

The periods and quality factors of free oscillations of the Earth remain among the strongest global constraints to infer the deep structure of the Earth. For instance, these data provide direct inference on parameters of geophysical interest as the density distribution, Brunt-Visl parameter N2 within the outer core, shear quality factor within the inner core, or the apparent viscosity at the outer core boundaries. In other respects, to be widely used in different applications, reference models must be as smooth as possible while adjusting these mean data. Such models are thus over-regularized. In a stochastic approach for instance, it leads to assign statistical parameters for the regularization that do not correspond to the true a priori information. It is therefore important to distinguish clearly the regularizing parameters from those which describe a priori information. The question then arises of how to evaluate the a posteriori uncertainty. In this communication, we show that, although a standard covariance analysis may not be carried out, it is possible to determine uncertainties in mean values between different radii of the parameters. Finally, this approach allows us to provide a more realistic inference on some of the geophysical parameters that account for the core structure.

Keywords: inversion, buoyancy, viscosity

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

JAS001 **Oral Presentation** **313**

Splitting of Normal Modes by Magnetic Field

Dr. Yves Rogister
EOST Universite Louis Pasteur Strasbourg I IAG

Bernard Valette, Mickael Delatre

We investigate the influence of the magnetic field on the splitting of the seismic normal modes. Tanimoto (1989) already considered a dipolar or quadrupolar toroidal magnetic field acting on the displacement field of the modes through the Lorentz force in the bulk of the outer core. He concluded that a strong magnetic field at the CMB is required to explain the anomalous splitting of a few normal modes sensitive to the structure of the core, which is usually explained by seismic anisotropy in the inner core. Earlier, Crossley and Smylie (1975) had considered a quadrupolar toroidal magnetic field and a magnetic boundary layer at the CMB. They had showed that the attenuation by magnetic field of core sensitive modes is very weak. Also considering a simple geometry for the magnetic field, we extend Tanimoto's and Crossley and Smylie's calculations by including the effects of (i) the Lorentz force in the bulk of the inner core and (ii) magnetic boundary layers at both the ICB and CMB. Whereas the magnitude of the magnetic field at the CMB is generally believed to be about 0.5 mT, it could be up to 50 times larger at the ICB. By computing the shifts of the eigenfrequencies and quality factors for split modes, we obtain an upper bound for the magnitude of the magnetic field at the ICB. Moreover, we explore the anomalous split modes.

Keywords: normal modes, splitting, magnetic field

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

JAS001 **Oral Presentation** **314**

Investigating the 2003 geomagnetic jerk by simultaneous inversion of the secular variation and acceleration for both the core flow and its acceleration

Mr. Luís Silva
Gomagntisme Institut de Physique du Globe de Paris

It is well known that the secular variation usually displays a constant secular acceleration (i.e. changes at a constant rate), except at times of so-called "geomagnetic jerks" when this secular acceleration suddenly changes its value. Those jerks are best seen in observatories. Unfortunately, the distribution of observatories is relatively sparse and very uneven at the Earth's surface. This has always been a strong limit to the possibility of investigating the cause of jerks. Fortunately, the availability of time-varying spherical harmonic models of the geomagnetic field, such as CHAOS (which was derived from the Oersted and Champ mission), provides new opportunities. CHAOS indeed happens to cover a time period (1999.5-2005.5) when one such geomagnetic jerk occurred (in 2003). It also happens to properly match the observatory data, and therefore provides the first truly global picture of a geomagnetic jerk, as inferred from a globally distributed set of data. In this study, we make use of the CHAOS model to investigate the 2003 geomagnetic jerk. Secular variation is assumed to be the result of Main Field flow advection under the frozen-flux and tangentially geostrophic assumptions. As a result, secular acceleration is also to be understood as the result of the combination of advection of the secular variation by the flow, and of advection of the Main Field by the flow acceleration. Those properties can then be used to simultaneously infer both the core flow and its minimum acceleration accounting for the field evolution at any given epoch. Doing this for the periods just before and after the 2003 jerk makes it possible to investigate both the average flow acceleration throughout the period considered, and the 2003 change in the flow acceleration (accounting for the geomagnetic jerk). Neither the average flow acceleration, nor the 2003 change in the flow acceleration can be accounted for in terms of toroidal zonal accelerations. This strongly suggests that geomagnetic jerks are more complex phenomena than a simple consequence of torsionnal oscillations.

Keywords: secula acceleration, flow acceleration

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

JAS001 **Poster presentation** **315**

Russian project "the moon – 2012+": interior structure of the moon

Dr. Alexander Gusev
Geopysics Kazan University, Russia IASPEI

In the report it is supposed: 1) to give the modern review of theoretical researches in spin - orbital movement of the Earth - Moon system; 2) to describe an internal structure of the three-layer Moon: internal rigid Fe core, external FeS a liquid core; the viscoelastic mantle on the basis of the modern seismic, satellite and laser data,3) to present and discuss the basic problems in geophysics of the Moon, 4) to depict lunar programs of leading space powers: "SELENE" (JAXA, 2007), "Chandrayaan" (ISRO, 2007), "CHANG'E-I" (CNSA, 2007), "LRO" (NASA, 2008), "Luna Glob" (Russia, 2012), paid special attention to the lunar program "SELENE" (Japan): " RISE " (2007), "ILOM" (2012) projects. The modeling of external and internal processes, acting on the rotation of a multi-layer Moon, the development of the theory of physical libration of the two/tree-layer viscoelastic Moon with a purpose to receive the observational effects of rotational modes of two-phase core, the geophysical interpretation of gravitation and topography anomalies at the lunar far-side on the basis of observations planned in the forthcoming space missions form the important direction in the study of dynamics and interiors of the Moon (Gusev, Petrova, 2006). The project will provide the development of the theory of the libration of the Moon, improvement of values of a core's radius, of lunar elastic characteristics, of initial conditions of the rotation, the theoretical estimations of tidal variations of the selenopotential and figure of the Moon. New model of tidal evolution of system the Earth–Moon will be constructed; allowing studying various resonant effects arising in the Earth - Moon system at the different stages of its dynamic history, the analysis of the subsequent evolution of resonant movements will be carried out. Results of global topographic cartography obtained by RISE-project (Kawano et al., 2003) of SELENE mission will be used to verify the hypothesis about the mantle's origins of positive gravitational anomalies on the far-side of the Moon. These are the positive gravitational anomalies, the elevation of a Moho-boundary, regional elevation of a lunar surface, the arch- type topographical lineaments, using the photo-tectonic technology decoding pictures of the far-side of the Moon. In-situ Lunar Orientation measurement (ILOM) is oriented to study lunar rotational dynamics by direct observations of the lunar physical librations from the lunar surface in the post-SELENE project. The scientific targets of ILOM project are the investigation of physical properties of the Moon: qualitative factor Q, Love number, excitation and maintenance mechanism of the free libration and free core nutation, core-mantle rotation. (Hanada, 2000).

Keywords: lunar interior

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

JAS001 **Poster presentation** **316**

Model of annual variation of oblateness of Mars and possible annual oscillation of its pole

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

The model of directed annual redistribution of masses of the Earth as a material point on its surface with harmoniously varied mass has been used effectively for dynamic interpretation and an explanation of observable annual oscillation of the Earth pole and variations of coefficients of the second harmonic of a geopotential (Barkin, 2007). The similar model with the purpose of interpretation and explanation of an annual variation of coefficients of the second and third zonal harmonics of the gravitational potential of Mars (marsopotential) dJ2 and dJ3, for a prediction of annual variations of other coefficients of the second harmonic of marsopotential, and also for the description of the possible phenomenon in rotation of Mars - the annual oscillation of its pole. The basis of research is the geodynamic model of the forced swing and wandering of the core and the mantle of the Earth under of a differential gravitational attraction of external celestial bodies (Barkin, 2002). On our geodynamic model observable constant displacement of the centre of mass of Mars relatively to geometrical centre (on distance of 2.85 km in direction of a geographical point 57 N, 82 E) there is a result of dynamic evolution of system of the core-the mantle. The identical displacement of the Mars core in same northern direction corresponds to displacement of the centre of mass of Mars (on preliminary estimations it can make 20-25 km). Evolutionary displacement of the core and a gravitational attraction of its superfluous mass have determined observable geodetic features of Mars. In particular the Mars bipolarity is one of the main dynamic consequences of offered model (Barkin, 2002). On Mars seasonal asymmetric rearrangement of polar ice caps from CO2 is observed. The seasonal variation of mass of northern cap is estimated by values 3.7x10 (15) kg - 8.6x10 (15) kg (Yoder et al., 2003). The seasonal variation of mass of a southern cap on 30-40 % is more than of northern cap. Air masses also asymmetrically distributed in southern and northern hemispheres of Mars. So in the winter the difference of air masses of northern and southern hemispheres makes about 4x10 (15) kg (Yoder et al., 2003). As well as in case of the Earth, we admit, that redistribution of atmospheric masses between hemispheres of Mars substantially is determined and directed by the polar oscillations of superfluous mass of the core which are caused by gravitational influence of the Sun on eccentric core. We expect that the core is displaced in winter to the north (here we have some analogy with the annual motion of the Earth core). The general seasonal asymmetric redistribution of masses of Mars we shall model by system of two points with cyclically varying masses located on the Mars surface at poles of geocentric axis OP, directed to the pole P with coordinates 57 N, 82 E (Barkin, 2001). Let due to redistribution of masses of the top spherical layer the masses of points change harmoniously under the law m1 = 10.81 sin (g+180) x10 (15) kg, dm2=8.72sin (g+180) x10 (15) kg, where g is a mean anomaly of Mars orbit. According to our model variations of coefficients of the second harmonic of geopotential J2, C21, S21 and coefficient of third zonal harmonic J3 of marsopotential have made: dJ2=1.81x10 (-9) sin (g), dC21=2.07x10 (-9) cos (g-180), dS21 = 1.48x10 (-9) cos (g-180), dJ3 =-6.69x10 (-9) sin (g). Variations dJ2 and dJ3 coincide with their values obtained by modeling constructions of changes of Mars caps and on the basis of the satellite data (Yoder et al., 2003). On the values of annual variations of products of inertia of Mars obtained here the annual variations of coordinates of a pole of an axis of rotation of the Mars have been estimated: dp/w=49.7x10 (-8) cos (g-126), dq/w=49.9x10 (-8) cos (g-125). References Barkin Yu.V. (2007) To model explanation of annual variation of oblateness and annual pole oscillations of the Earth. Abstracts of IUGG XXIV (Perugia, Italy, 2-3 July 2007). 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. Yoder C.F., Konopliv A.S., Yuan D.N., Standish E.M., Folkner W.M. (2003) Fluid core size of Mars from detection of the solar tide. Science, vol. 300, 11 April 2003, pp. 299-303.

Keywords: mars, core, pole

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

JAS001 **Poster presentation** **317**

The effect of magnetic field on thermal convection in a rotating annulus

Dr. Milos Revallo
Department of Geomagnetism scientific worker IAGA

The problem of thermal convection in an electrically conducting fluid contained by a rotating cylindrical annulus in the presence of magnetic field is considered. This is one of the classical convection models which has been designed to capture the fundamental properties of convective motion in the Earth's outer core. Linear stability analysis known from earlier studies shows that two convective modes can emerge within certain parametric regime. In this study we perform weakly nonlinear analysis and find stability domains for single-mode and mixed-mode convection. We also derive the system of complex Ginzburg-Landau equations describing spatially non-homogeneous convective modes. Our findings indicate that applied magnetic field plays destabilizing role. The small gap approximation and the geophysically feasible limit of high rotation rate are considered throughout the study allowing for analytical progress.

Keywords: convection, stability, nonlinear

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

JAS001 **Poster presentation** **318**

Paleomagnetic Pole Locations Deduced From Lunar Strong Magnetic Anomalies: A Possible Pre-existence of a Global Dipole Field

Dr. Berguig Sherif
Paris IPGP IAGA

Yves Cohen, Mohamed Hamoudi, Mark Wieczorek

Locations of paleomagnetic poles positions of the Moon determined by inverting Lunar Prospector magnetometer data over high albedo regions are presented. The selected data used for this work are the measurements of the magnetic field at low altitudes collected by Lunar Prospector satellite. Those selected data are less disturbed by the solar wind. Firstly the lunar magnetic field is extracted by separating the internal and the external signals from the Lunar Prospector magnetometer data. Thereafter the localised lunar magnetic anomalies are inverted to determine paleomagnetic poles directions. Four small-size high albedo features (Reiner gamma, Descartes, Mare Ingenii and Mare Marginis) were modelled by simple body like thin circular disks. These selected formations are most probably of Imbrian age (Halekas et al., 2001; Hood et al., 2001; Richmond et al., 2003). Three nearby paleomagnetic poles positions were obtained over these high albedo zones centered on (10S; 220E) suggesting a lunar remanent magnetization possibly acquired in the presence of a global core dipole field. The dispersed positions of paleomagnetic pole locations obtained over some Imbrian craters suggest that this lunar crust remanent magnetization were since modified by subsequent impact events.

Keywords: lunar magnetic anomalies, paleomagnetic pole locations, global core dipole field

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

JAS002 **319 - 343**

Symposium
Large scale imaging of the continental and oceanic lithosphere

Convener : Prof. T. Harinarayana
Co-Convener : Dr. Kerry Key

Mapping of the internal structure of the continental and oceanic lithosphere is important to understand the dynamics of the Earth. Variation of electrical conductivity reflects structural and petrophysical properties. Anomalous conductive features give clues for the existence of graphite, saline water or partial melt and throw light on the rheological properties. The objective of the session is to bring together the recent theoretical, observational and experimental studies on deep crust and mantle studies at various active and passive regions of the continents as well as oceans with a focus on the relationships with deep geological processes and tectonic interpretation. Large-scale regional studies derived from geomagnetic and magnetotelluric soundings will constrain the models that lead to new interpretation of the processes

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

JAS002 **Oral Presentation** **319**

Delineation of subsurface structures and tectonics of Marsa Matrouh area, western desert, Egypt, as deduced from magnetotelluric and magnetic data

Dr. Ahmed Khalil
Geomagnetic and Geoelectric department National Research Institute of Astronomy and Geoph IAGA

El Kotb Ahmed, Mohamed El Bohoty

This work is aimed at delineating the subsurface structures and tectonics setting of Marsa Matrouh area, western desert, Egypt, using a combination of magnetotelluric (MT) and magnetic data. For the execution of this investigation, the authors carried out six deep magnetotelluric soundings with about 9 km distance. The used frequency of the MT data was ranging from 1 to1000s. Six magnetotelluric soundings have been recorded simultaneously during two weeks of measurements. Interpretation of polar and skew plots has been presented for the MT soundings. Also, interpretation of the apparent resistivity and phase curves as well as pseudosections of apparent resistivity and phase data from the transverse electric (TE) and transverse magnetic (TM) polarizations have been done. One-dimensional electrical resistivity modeling is carried out to look for the best geological model able to explain the measured data. In particular, 1D of determinant invariants at each site indicates that a number of high and low-resistivity zones exist in the sediments. The magnetic method of prospection gives an effective presentation of the subsurface structures, thus a detailed land magnetic survey over an area of bout 100 km2 is needed for focusing the active importance structures and tectonics in the surveyed area. To achieve this goal, 170 land magnetic stations were measured using two Proton magnetometers, one of them as a local reading base station placed in the middle part of the area, while the second was used for measuring the total intensity of the different points. The necessary reduction concerning the daily variation, the regional gradient and the time variation were applied. Then the total intensity anomaly map was constructed and reduced to the magnetic pole (RTP). This step was followed by application of the filtered technique, Euler deconvolution and 2D magnetic modeling techniques. The results of magnetic interpretation revealed that, the area under investigation has been affected by two main tectonic trends taken the direction NE-SW and NW-SE. The result of depth estimation to the basement complex revealed that, the depth of the basement ranging between 2.5km and 3.5km.

Keywords: magnetotelluric, magnetic

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

JAS002 **Oral Presentation** **320**

A Continent-wide Map of Lg Coda Q Variation across Eurasia and its Relation to Lithospheric Evolution

Prof. Brian Mitchell
Earth & Atm. Sci. Saint Louis University IASPEI

Lianli Cong

We present new maps of Lg coda Q and its frequency dependence at 1 Hz (Qo and eta, respectively) that cover virtually all of Eurasia. Our new data set, which nearly quadruples the number of previously available measurements, provides coverage for virtually the entire continent. Qo is relatively high, up to 700 and more, in most cratonic regions but is surprisingly low in the Arabian craton (300-450), the Siberian trap portion of the Siberian platform (~450) and the Deccan trap portion of the Indian platform (450-650). It is generally low throughout the Tethysides orogenic belt but there too it displays substantial regional variations (150-400). All major Qo anomalies, and several relatively minor ones, appear to be related to the tectonic history of the Eurasian lithosphere. The four regions with lowest values approximately coincide with four out of the five most seismically active earthquake concentrations in Eurasia. Observed Eurasian Qo variations are consistent with a previously developed plot of global values in which Qo in any region is directly proportional to the time that has elapsed since the most recent episode of tectonic or orogenic activity there. Our favored explanation for this evolution in Qo values is that it is produced by the dissipation with time of crustal fluids either by loss to the surface or by retrograde metamorphism. Comparisons of the new Qo map with continent-wide maps of long-period Rayleigh-wave phase velocities, short-period Rayleigh-wave group velocities, upper mantle temperatures, subducted lithosphere and available information on crustal strain supports our previously proposed paradigm that hydrothermally-released fluids in the upper mantle travel to the crust and begin a long process of dissipation that leads to the Qo distribution of that we see today. Some lower than expected values in central and southern Asia suggest that the fluids were produced by some documented, and some yet undiscovered, subduction zones that were active during Paleozoic and Mesozoic time.

Keywords: lg coda q, attenuation, eurasia

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

JAS002 **Oral Presentation** **321**

Magnetotelluric Survey Across The Contact Of Proterozoic Eastern Ghat Mobile Belt And Singhbhum Archean Craton ,Eastern India

Prof. Kalyan Kumar Roy
Dept. Geol.Sci.Jadavpur University,Kolkata.India Emeritus Scientist IAGA

Suman Dey, Someswar Srivastava

Magnetotelluric survey was conducted across the northern margin of the Proterozoic Eastern Ghat Mobile Belt(EGMB)and the southern margin of the Archaean Singhbhum granite batholith for a stretch of about 200 km from Khorda near Puri to the north of Keonjhargarh in Orissa.The transect cuts across the Mahanadi Graben, Athgarh Sandstone,some of the major geologically verified faults in EGMB ,Sukinda thrust the Archaean-Proterozoic contact and Singhbhum granite batholith phase-II. The data are interpreted using both RRI and Rebocc inversion source codes.The period range of the MT signal was from 0.25 seconds to 4096 seconds.The study show that high grade khondalite,charnockite and granulite facies rocks do not exist below the depth of 8 to 10 km from the surface..Very thick lower crustal conductor exist along the entire stretch of the transect.Deep seismic sounding also reported the presence of highly ductile rocks in the study area below 8 to 10 km.Higher ductility and higher conductivity go together.Higher conductivity of the lower crust may be due to the combined effect of presence of high temperature pockets,origin of grain boundary graphites from CO2 phase exhumation from the uppermost mantle or generation of water from breaking of Phlogopites ,Muscovites and Biotites obtained from the Proterozoic Khondalites and Charnockites of EGMB.Surface signatures of some higher temperature pockets do exist near Khorda area.In the presence of thick lower crustal conductor,MT signals could see upto 40km from the surface.In view of the significantly simple 1D type of structures and significant contrast in electrical conductivity at Moho depth, signature of Moho is visible here.Seismic Moho is detected at a depth of 34 km where as electrical Moho is detected at a depth of 38km.Signature of the Mahanahi graben could be retrieved with greater detail.Electrical conductivity 2D models revealed the signature of the major exposed faults.These faults support the idea of collision tectonics of the Proterozoic EGMB with Archean cratons of Singhbhum.Sukinda thrust,the Archean-Proterozoic contact could be mapped.Singhbhum granite batholith is about 20 to 30km thick below KeonjhargarhVery high resistivity of Singhbhum granite batholith(10,000 + ohm-m)made the mapping prominent.

Keywords: magnetotallurics, continent, imaging

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

JAS002 **Oral Presentation** **322**

Imaging the electrical characteristics in the deep crust across Narmada Tapti Lineament zone in Central India

Prof. T. Harinarayana
National Geophysical Research Institute, Hyderabad Scientist IAGA

K. Naganjaneyulu, B. P. K. Patro, M. Someswara Rao, G. Virupakshi

The central Indian region of Indian subcontinent is distinguished with major tectonic features that assume a long history of crustal movements since the Precambrian to Recent times. The major tectonic features in the area include Narmada-Son Lineament, Tapti lineament and associated fault structures such as Gavligrh fault, Barwani-Sukta fault, etc. Due to the significant role of these structures in the tectonic setting of the region, many geophysical observations, including magnetotellruic (MT) images, were made across the central Indian tectonic features. In order to increase the knowledge about the tectonic settings of the area, new MT measurements are carried out to image the deep crustal electrical resistivity variations associated with the prominent tectonic structures. The MT data are acquired along ~180 km long profile, with ~ 12 km station interval, crossing the major east-west trending regional tectonic features. The data, after processing anddetailed analysis, are inverted to obtain the two-dimensional resistivity model. The model shows enhanced conductivity features at deep crustal depthsrelated to the major fault zones. In addition, the resistivity model gives thickness constraints of the previous estimations on the Basaltic cover and Mesozoic sedimentary formations.

Keywords: magnetotellurics, electrical conductivity, deep crust

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

JAS002 **Oral Presentation** **323**

The resistive oceanic lithosphere and the deep mantle structure beneath the northwest Pacific basin

Dr. Hiroaki Toh
Earth Sciences University of Toyama IAGA

Tsutomu Motobayashi

For three and half years, geoelectromagnetic variations have been measured at the seafloor in the northwest Pacific (Toh et al., 2006). The seafloor site is called NWP and located at (41 06 08 N, 159 57 47 E, -5580 m), thatis in the middle of the northwest Pacific basin as old as 129 Ma (Nakanishi et al., 1999). This site has provided high quality electromagnetic (EM) time series with a sampling interval of one minute, and yielded both magnetotelluric (MT) and geomagnetic deep sounding (GDS) responses for subsequent one-dimensional (1D) inversions with smooth constraints (Constable et al., 1987). It was found that the determinant averages (Berdichevsky and Dmitriev, 1976)of the observed MT tensor elements for periods ranging from 1,000s through 1 day do not match the apparent resistivities determined by the GDS-converted scalar impedance (Schultz and Larsen, 1987), while the observed MT and GDS phases are smoothly linked togetherfor periodsfrom 1,000s through30 days. The discrepancy in the MT and GDS amplitudes, therefore, was interpreted as arising from the regional distortion of the seafloor geoelectric field caused by the so-called coast effect. Thediscontinuos apparent resistivity curve was re-connected using rho+ algorithm (Parker and Booker, 1996) by upward shift of the observed MT apparent resistivity in order to fulfill the 1D causality required by both the observed GDS apparent resistivity and the joint phases. It was also found that the thus determined static shift factor can be used to constrain the Resistivity-Thickness Product (RTP; Cox, 1980) of the oceanic lithosphere in the northwest Pacific. Two-dimensional forward modeling of the oceanic lithosphere and subduction at the Kuril trench closest to NWP further revealed that RTP beneath the northwest Pacific is of the order of1010 ohm.m2, which is one order of magnitude larger thanRTP beneath the northeast Pacific (Constable and Cox, 1996). This can be interpreted in terms of lower temperature and/or absence of volatile elements such as water in this very old lithosphere. The deeper mantle structure beneath the resistive oceanic lithosphere is also reported in this paper, since the long-period EM data turns out to have sensitivity to structures as deep as 850 km. In short, the deeper part of the derived 1D model is characterized as follows: (1) A conductive asthenosphere centred at a depth of 200 kmis strongly required by the data, and this portion of our 1D model is quite similar to that beneath the northeast Pacific (Lizarralde et al., 1995). (2) At the mantle transition zone depths, the electrical conductivity increases by factors of approximately 10 and 2 at 410 km and 660 km, respectively. The increase of the electrical conductivityat 660 km was found better constrained by the data. (3) The electrical conductivity of the lower mantle beneath the northwest Pacific basin is around 1 S/m, which is compatible with the electrical conductivity of a dry and aluminum-containing perovskite. The interpretation of those features above will be furthergiven in terms of water content in the mantle beneath the northwest Pacific basin.

Keywords: the northwest pacific basin, coast effect, resistivity thickness product

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

JAS002 **Oral Presentation** **324**

Proterozoic-Type Tectonics of Mars Revealed From Magnetic Anomalies

Prof. Jafar Arkani-Hamed
Department of Physics University of Toronto IAGA

Andrew Hynes

The distinctly different tectonic regimes of the Archean and Proterozoic have resulted in distinctly different patterns in the magnetic anomalies of North America and Australia. Both continents have broad spectra of geological provinces ranging from the Archean to Proterozoic and Phanerozoic eras. The wealth of aeromagnetic data for the two continents provides a unique opportunity to investigate the global characteristics of the magnetic patterns for terrains from each era. The magnetic anomalies of the two continents are first reduced to the pole using differential reduction to the pole technique, and then upward continued to altitudes of 10, 100, and 400 km. The 10 km altitude anomalies are almost entirely devoid of very short wavelength components, and show the magnetic effects of regional tectonics. The 400 km altitude anomalies are produced to allow comparison of the aeromagnetic anomalies with satellite anomalies. The 100 km altitude anomalies are to be compared with the Martian magnetic anomalies at a similar altitude. The magnetic anomalies of the Archean are typically characterized by small scale features due either to the presence of small plates or to the disruption of large-plate signatures by late granitoid intrusion. On the other hand, the pervasive continent-size plates of the Proterozoic have created elongated magnetic anomalies due to demagnetization of the plate boundaries in the process of continent-continent collisions and to the development of large, subduction-related granitoid batholiths. We derive the magnetic anomalies of Mars at 100 km altitude using Mars Global Surveyor night-time magnetic data acquired at an altitude range of 360 to 430 km during 6 years of its mapping phase operation, 1999 to 2005. The original data are expressed in terms of spherical harmonics of degree up to 90. A global scale magnetic anomalies map is constructed using harmonics of degree up to 60, which are almost devoid of contamination by non-crustal sources. The strong magnetic anomalies in the southern hemisphere of Mars over Cimmeria and Sirenum Terrae extracted from the global map resemble the anomalies associated with Proterozoic provinces of North America and Australia. This indicates that Proterozoic-type tectonics were likely operating during the early history of Mars prior to the development of a globe-encircling stagnant lid, as Mars became a one-plate planet.

Keywords: magnetic anomalies, north america, mars

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

JAS002 **Oral Presentation** **325**

High resolution seismic reflection image of the Achankovil shear zone and its relevance in interpreting the pan-african event

Dr. Rajendra Prasad Bitragunta
Project Leader, CSS Project National Geophysical Research Institute IASPEI

B. Rajendra Prasad, P. Koteswara Rao, S. Raju

National Geophysical Research Institute has undertaken multi fold seismic reflection/refraction survey as major component of integrated geophysical study along the Vattalkundu-Kalugumalai-Kanyakumari (260 km long) transect to investigate the deep crustal structure of the south Indian shield to identify, refine and prioritize the scientific issues related to the south Indian lithosphere. The Southern Granulite Terrain (SGT) constitutes a large part of the South Indian Precambrian shield. The area exposes many crustal-scale thrust faults and important tectonic lineaments like the transition zone, the Moyar-Bhavani, Palghat-Cauvery and the Achankovil shear zones. All these zones appear to have played a major role in the evolution of the continental lithosphere in this region. The Achankovil Shear Zone is a prominent tectonic feature separating Madurai block to the north and the Kerala-Khondalite Belt (KKB) to the south.A state of the art 240-channel 24-bit RF Telemetry Seismic data acquisition system, with all its accessories has been deployed for the first time to acquire deep seismic reflection and refraction data along the Vattalkundu-Kanyakumari profile. The seismic data acquisition operations along the entire transect are carried during 2004-05. The seismic refraction data was acquired from six wide-angle shots spacing is ~40 km and geophone (4.5 Hz) interval of ~100 m with continuous spread at different offsets fro each shot to acquire long offset data.The seismic stack sections along the entire profile, showing conspicuous changes in reflectivity pattern, indicate tectonically disturbed crustal blocks. The south dipping reflections in the southern part of the profile, between Sivakasi and Kalugumalai in the upper crust are strong and continuous. The increased reflectivity observed in the stack sections, is consistent with the degree of ultrahigh-temperature metamorphism reported in the region. In general, the region is characterized by good upper and mid crustal reflectivity but diffused Reflection Moho at 13.0 13.5 s two way travel time (TWT) between Vattalkundu-Kalugumalai. Travel time tomography and 2D Velocity modeling along Vattalkundu-Kanyakumari constrained down to maximum 8 km depth show velocity anomalies within the shear zones with good spatial resolution, indicating significant compositional changes of rocks at shallow depths (0.5 to 8 km) reveal rapid crustal exhumation of mid to lower crustal rocks. This crustal exhumation could have been due to Pan-African tectonothermal activity during Neoproterozoic period. Encouraged by the preliminary results along the main profile, an additional 47 km long profile parallel to the main profile from Shanmughanallur to Ambasamudram was shot. This profile is located 30 km south west of the main transect across AKSZ. As the objective of the profile was to image the AKSZ, 240 channels data was acquired at 1 ms sampling interval at closer shot spacing of 100 m and receiver group interval of 50 m. This study has brought out the expected high resolution seismic image of the AKSZ . These result help to understand the attitude and dip and dimensions of this massive, crustal scale shear zone and its lateral and depth extension. The data from both the profiles can be effectively used and compared to ascertain the nature and kinematics of the AKSZ

Keywords: southerngranuliteterrain, achankovilshearzone, highresolutionseismicimages

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

JAS002 **Oral Presentation** **326**

Do we need graphite, brines and partial melts to account for crustal electrical conductivity variations?

Prof. Friedemann Freund
Earth Science Division, Code SGE NASA Ames Research Center IAGA

Electrical conductivity anomalies are typically discussed in terms of rocks with interconnected carbon or graphite films, interconnected brines or partial melts. It is widely but erroneously believed that no other process exists to cause anomalies in the conductivity structure of Earths crust. There is a solid state process, long overlooked, that strongly influences the electrical conductivity of rocks (1). It is based on valence fluctuations in the oxygen sublattice of minerals. The valence fluctuations arise among oxygen anions converted from their 2- to the 1- state. This conversion involves hydroxyl pairs in nominally anhydrous minerals, splitting off H2 and converting to peroxy, O3Si-OO-SiO3. The conversion takes place during cooling under non-equilibrium conditions. At crustal temperatures up to about 300C, the peroxy are undissociated. Between 300C to 600C they break up, increasing the number density of charge carriers by generating loosely bound electrons plus O. The O represent defect electrons (positive holes or pholes for short). They propagate through the valence band by way of a phonon-mediated electron hopping with a theoretically predicted and experimentally confirmed phase velocity (2) of 200 50 m/s. Above 500-600C the O are irreversibly consumed. O2/O valence fluctuations introduce a new aspect into the discussion of the crustal, possibly upper mantle, electrical conductivity structure. (1) Freund (2003), On the electrical conductivity structure of the stable continental crust, J. Geodynamics, 35, 353-388; (2) Freund and Sornette (2007), Electromagnetic earthquake bursts and critical rupture of peroxy bond networks in rocks, Tectonophys., 431, 33-47.

Keywords: conductivity inhomogeneities, electron hole conductivity, crust

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

JAS002 **Oral Presentation** **327**

Indication of the deep tectonics by resistivity and phase anisotropy, invariants and phase tensor parameters in a three-dimensional sedimentary basin

Mr. Attila Novak

Electromagnetic Induction HAS GGRI, H-9400, 6-8. Csatkai E. Sorpon, Hungary IAGA

Antal Dm, Lszl Szarka

In SW-Transdanubia, Hungary, the Hungarian state oil company carried out in the 1980-s about 300 MT soundings along 14 parallel profiles. The MT sites form a quasi-grid with a distance of about 2 km. We applied various MT interpretation approaches to this MT data set. In the first step we identified the TE and TM modes, and determined the structure of the high-resistivity structure (in several variants) by using 1D inversion. The structure of the 3D sedimentary basin was constructed from the 2D inversion of the parallel profiles, and verified by 3D forward modelling. Resitivity and phase anisotropy, WAL invariants and phase tensor parameters at various periods were also calculated. The Mid-Hungarian line, separating the two microplates of the Pannonian Basin, namely of the Alcapa and the Tisia, crosses this area. The Mid/Hungarian line, in contrast to the Balaton line, another characteristic tectonic line of the area, proved to be much more intermittent. Its continuation could be followed the best by using various invariants.

Keywords: magnetotellurics, invariant, transdanubia

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

JAS002 **Oral Presentation** **328**

Gravity anomalies over India and their relevance to lithospheric structure

Dr. Venkata Ram Babu Hari
National Geophysical Research Institute Council of Scientific & Industrial Research IAGA

The gravity anomalies over India show good correlation with major tectonic elements and reveal structure of the crust and lithosphere. For example, the Narmada-Son lineament, Godavari and Mahanadi rifts, Aravallis and the Eastern Ghats are shown up prominently on the Bouguer gravity image. The gravity trends defined as the axes of elongated lows or highs reveal that the Indian landmass is a mosaic of about 12 crustal blocks that are either sutured or separated along the rift valleys. The relative ages of these blocks were identified from gravity trends. The radial spectrum of gravity anomalies provide an average crustal thickness of about 32 km and lithospheric thickness of about 115 km. A correlation of gravity anomalies and crustal thickness inferred from deep seismic sounding data reveal that the average crustal density is about 2860 kg.m3. The long wavelength (200 km) anomaly interpreted in terms of crustal thickness provide 32 km thick crust along the Eastern Ghats and 40 km thick crust in the Western Dharwar craton. The short wavelength anomaly and the first vertical derivative images correspond more closely with local geology.

Keywords: gravity, indian lithosphere

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

JAS002 **Oral Presentation** **329**

Crustal imaging and tectonic evaluation over parts of shillong plateau using aero magnetic data

Mr. G.D.J. Sivakumarsinha
Aiborne Geophysical Surveys Division National Geophysical Research Instiute

The tectonics of North Eastern India in general and Shillong Plateau in particular are among the most interesting of the various regions of Indian sub-continent. Here large scale thrust movements from two opposing directions have occurred, resulting in crustal shortening estimated to be of the order of 150-300 kms (Evans, 1964). Along with crustal shortening horizontal movements on a very large scale are inferred to have taken place along well defined faults such as the Dauki fault, resulting in movements of large blocks through distances. Geological evidence points to vertical movements resulting in uplift of large masses as the Shillong plateau and Mikir hills. In such a tectonic environment, there is possibility of structural disturbances at various levels in the crust. A regional aeromagnetic survey was carried out over parts of Shillong plateau and Assam valley with a line spacing of 2km, line direction of North 30 west at barometric heights of 7500ft and 4600ft a.s.l during 1978 by National Geophysical Research Institute, Hyderabad, India. The aeromagnetic map has been studied and interpreted in terms of crustal geology. The aeromagnetic lineament pattern and the magnetic anomaly modeling (spectral analysis) over certain parts of Shillong plateau has inferred the presence of large scale intrusives which have influenced the crustal tectonics. The results are discussed and presented.

Keywords: aeromagnetic, shillong plateau, lineament

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

JAS002 **Oral Presentation** **330**

Lithospheric structure across the southern part of the continental margins of India

Dr. Bijendra Singh
National Geophysical Research Institute, Hyderabad Scientist IASPEI

Niraj Kumar, A. P. Singh

Southern part of the Indian shield consists of high grade Granulite terrain. In order to delineate the crust and upper mantle structures, the new gravity data acquired over the Granulite terrain is combined with the satellite gravity data over the adjacent Arabian andBay of Bengal regions. A composite gravity anomaly map of the land and adjacent sea has been prepared. The most prominent features of the maps are (i) long wavelength regional gravity low associated with the Palani-Cardamin Hills suggesting crustal root due to isostatic compensation and (ii) coast parallel positive gravity gradient and pairs of linear gravity high and low parallel to the coasts near the shelf break. However, amplitude of these anomalies differs significantly at the margins despite the fact that nature of bathymetry is same. For example, the magnitude of gravity high is much larger at the western margin where as gravity low is prominent at the eastern margin. The large wavelength bathymetry feature shows a positive correlation with Free-air anomaly indicating some form of isostatic compensation.The lithospheric structure derived from the modelling of long gravity traverses cutting across the eastern and western continental margins indicate thickening of crust from about 12 km. in the oceanic part to about 35 km. beneath the continent. While modelling the gravity anomalies across the margins, geophysical information available along the N-S geo-transect has been incorporated. Modelled sections indicate that the large wavelength regional anomalies are largely explained due to variation in Moho geometry. The NW-SE trending gravity gradient at the eastern margin reflect shelf edge effect of continent-ocean transition and is fairly well accounted by the Moho geometry. On the other hand, the large amplitude, coast parallel, gravity high near the shelf break at the western margin requires high-density mafic intrusion in the transitional crust. Therefore, there is a contrasting dissimilarity in crustal configuration at the continental margins in this region. Presence of high density and high velocity igneous intrusion in the form of underplated layer has been reported at many rifted margins. It appears therefore that, the NNW-SSE trending linear feature may be related to magmatism at the time of rifting of from along the pre-existing Precambrian basement faults during late Cretaceous. It differs considerably from the N-S trending Chago-Laccadive and Ninety-east Ridge system, which owe their origin due to hot spot volcanism.

Keywords: isostasy, continentalmargins, underplating

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

JAS002 **Oral Presentation** **331**

Large-scale EM experiments: An overview of capabilities, actual research and new techniques

Dr. Heinrich Brasse
Fachrichtung Geophysik FU Berlin IAGA

Electromagnetic deep sounding methods have recently become a major aspect in the study of continental and oceanic lithosphere. They are often applied in a wider framework of large-scale experiments, encompassing particularly passive and active seismology, in virtually all tectonic settings. Due to their potential to extract information about temperature, fluid and melt contents via electrical conductivity at depth, they are more and more seen as an indespensable tool in the investigation of lithospheric structures. The current boom in carbon hydrate exploration has additionally drawn attention towards EM methods, fostering in particular offshore and amphibious applications. Furthermore, monitoring experiments, e.g., at volcanoes and major fault zones are now frequently conducted, often in conjunction with seismological and GPS observations. Major targets of lithospheric research where deep EM may significantly contribute include among others a) imaging of the fluid/melt cycle in subduction zones from the seismogenic zone via downgoing slab and asthenospheric wedge; b) the Lithosphere-Asthenosphere boundary; c) mapping of large active as well as fossil shear zones, their image at depth and thus a reconstruction of recent and former tectonic regimes; d) geothermal questions and related topics in volcanology, to mention a few. State-of-the-art techniques include the setup of large arrays with many stations operating simultaneously in a wide frequency range. This allows not only the determination of classical magnetotelluric transfer functions (impedance and tipper) but also the calculation of magnetovariational (inter-station) transfer functions in the study areas. Until today the layout of station networks is usually done along profiles across potential targets, but the availability of more instruments and particularly the advance in full 3-D modeling and inversion will overcome the inherent difficulties concerning validity of the underlying 2-D assumptions and the problem of distortion associated with the electrical field. This contribution will focus on the application of EM methods in the investigation of subduction/collisional processes and the study of structures in old continental environments. Resolution capabilities and limitations will be addressed as well as the correlation with other geophysical findings, particularly seismic velocities and attenuation. Exemplary case studies from the Andes, Tibet and North America will be shown which demonstrate the potential of the methods and the reconciliation of sometimes conflicting results of various geophysical approaches. Open questions shall be addressed with special emphasis on resolution in a complicated geological background.

Keywords: electromagnetics, subduction, faults

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

JAS002 **Poster presentation** **332**

Geoelectric structure of the Deccan Volcanic Province observed from magnetotelluric studies

Dr. Gautam Gupta
IAGA

S.G. Gokarn

Magnetotelluric studies over two profiles in the southern part of the Deccan Volcanic Province (DVP) have delineated a top layer with resistivity in the range of 50-200 Ohm-m and thickness varying between 1 and 3 km. This layer predominantly comprises of the Deccan basalts and pre-Trappean sediments. The entire crust beneath the Deccan basalts has a high resistivity of more than 1000 Ohm-m. The studies around the Panvel flexure in the southern DVP are indicative of crustal stretching as is evident from the thinning of the crust in the central part of the profile corresponding to the western Ghat escarpment region. This observation along with the observed flexure is indicative of extensional tectonic regime. An anomalous high conductivity zone is delineated at depth of about 60 km corresponding to the lithospheric mantle in the southern profile, which seems to correspond to the thermal fluxes caused by the Reunion hot spot, over which this region may have passed during the eruption phase of the Deccan magma.

Keywords: deccan volcanic province, magnetotellurics, conductivity

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

JAS002 **Poster presentation** **333**

Deep-seated conductivity anomaly next to the andean range suggested by magnetotelluric and magnetovariational studies in Mendoza, Argentina

Dr. Enrique Borzotta
Unidad de Geofísica, IANIGLA, Mendoza, Argentina CONICET, Argentina IAGA

As it is known, a geological change happens at about 32 S Lat. in the Andean Range: from this latitude toward the North there are not volcanos and high seismicity exist, while less seismicity and volcanos, many of them active, are present toward the South, among them, the Tupungato Vn. with an altitude of 6800 m a.s.l. Two deep magnetotelluric soundings (MTS) were carried out in this transitional zone, next to the Andean Range NS separate 50 km each other. In addition, the comparisons between the horizontal geomagnetic variation field in both locations with the synchronous records from the Pilar Geomagnetic Observatory (PGO) were carried out (MVS). Z components are not available. The interpretation of one MTS, located 57 km eastward from Tupungato Vn., shows a high conductive layer -possibly the lower crust- with 2800 Siemens of conductance (27 - 34 km depth). MV studies support this MT result and give consistent evidences of a deep-seated conductivity anomaly (CA) in the region. In fact, some magnetic events, at one MT site, (15min to 20min of periods, and N60W polarized) almost duplicate the D amplitude ratio respect to PGO, being this ratio about 1.60 in the other MT site, also showing important changes in polarizations respect to PGO. As a conclusion, a deep-seated CA is thus suggested in this region, between 32 to 34 S Lat., running with a general strike N30E. This CA could be related with the high conductive lower crust -presents in this active volcano zone- and a megafault crossing the crust. As a speculation, and according to its strike, this fracture possibly belongs to the ancient deep fractures corresponding to the planetary network in this region. Partial melting of rocks is the principal candidate to explain this CA. However, graphite could have a role, taking into account that is one of the principal mineral presents in the basement in this region.

Keywords: magnetotelluric, magnetovariational, anomaly

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

JAS002 **Poster presentation** **334**

A 2-D resistivity modeling of the southern sector of the Pringles Metamorphic Complex, Sierra de San Luis, Argentina

Dr. Cristina Pomposiello
CONICET IAGA

Monica G. Lpez De Luchi, Alicia Favetto

Ultramafic-mafic igneous intrusions of the Virorco district form part of a NNE trending belt of Ordovician mafic plutonic lenses located in the Pringles Metamorphic Complex (PMC) the central basement domain of the Sierra de San Luis (Eastern Sierras Pampeanas),where high temperature low/medium pressure (5.7-6.4 kbar/740-790C) granulite facies rock constitute their host rock. Whole rock major and trace element compositions indicate that the parent magma was gabbroic/basaltic and was generated in a subduction-related arc, or back-arc settings. The belt of mafic-ultramafic intrusions host nickel sulfide resources and contain significant Cu, Co and PGE mineralization. Using pre-existing resistivity and chargeable data 2D and 3D models were obtained. Resistivity anomalies are located along two eastern and western parallel corridors located outside the area of most continuous outcrops of the orthopyroxene gabbro. These anomalies could be controlled either by a particular enriched rock facies or by a structural feature, being in this last case an indication of a secondary mineralization. Model output shows that the bodies that are responsible for the PFE% and FM anomalies extend down to 200 m. The vertical attitude and location of the eastern anomaly are coincident with ductile shear zones that affect the contact between the mafic intrusion and the host rocks .In this area a 150 m vertical sounding cut across the metamorphic host. The western anomaly is located below an area in which the metamorphic host is interlayered with horblendiferous diorites. It is possible that this contact surfaces between rocks of different rheology could act as weakness zones in which ductile deformation was concentrated. Ductile shear zones could have channelized fluid circulation that mobilized the original mineralogy and led to its concentration. Therefore in the southern sector of the Virorco ultramafic-mafic unit the mineralization is associated with the regional steep high- temperature shear zones, the activity of which is Ordovician. Furthermore, MT sites using two commercial wideband receivers (EMI MT-24) with a data bandwidth of 0.01 to about 300 s were collected around the bodies. Resistivity anomalies are found at approximately 5000 m depth. It is not clear if these deeper anomalies have the same origin that the shallower ones.

Keywords: ultramafic mafic unit, magnetotelluric, resistivity anomalies

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

JAS002 **Poster presentation** **335**

First multi-site magnetotelluric experiment in Egypt: opportunities of remote reference technique

Dr. Ahmed Khalil
Geomagnetic and Geoelectric department National Research Institute of Astronomy and Geoph IAGA

Abdou Khalaf

In the traditional application of magnetotelluric (MT) method at a point (station), two horizontal components of the electric field Ex and Ey and the three orthogonal components of the magnetic field Hx, Hy and Hz are measured simultaneously at the same point in the form of time series. The present study is a trial to test the MT method with the three magnetic components measured at a remote magnetic reference site (geomagnetic observatory) instead of the three magnetic components measured in another sounding site with the electric field components and to study the effect of the distance between the location of remote magnetic reference and field station. The general procedure was based on simultaneous measurements with two MT instruments with different distances between them. The resultant magnetic records at the remote reference station analyzed with the electric field records simultaneously measured at another point and vice versa. In this work, MT measurements were carried out in the period range from 1 to 10000s, in the same time at Misallat geomagnetic observatory (as a remote magnetic reference) and at different magnetotelluric stations along EL- Fayoum Cairo Road. Magnetotelluric sensors were used to measure fluctuations in two orthogonal horizontal components of the magnetic field. The data were processed with modern techniques presently available. Smooth curves of apparent resistivities, phases and skewnesses as function of period for all stations were obtained. Also, the coherency parameter is sensitive to noise and some sites display similar sounding curves. According to the value of correlation factor, the maximum separation between the stations measured by magnetotelluric instruments in different sites and the station measured by magnetotelluric instrument at Misallat observatory (Remote reference station) was about 40 km. The analyses reaffirm the necessity of a careful choice of the station to be used as reference in the remote reference technique. The advantage of this method is the possibility of applying MT at a site by measuring the horizontal electric field components only at this site and analyzing them with the magnetic records of a remote instrument or observatory.

Keywords: magnetotelluric, remote reference

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

JAS002 **Poster presentation** **336**

Electromagnetic induction mosaics from two significant tectonic lines of the Pannonian Basin and the Alps

Prof. Laszlo Szarka
Geophysical Department Geodetic and Geophysical Research Institute IAGA

Antal Dm, Gza Varga

In the area of the Pannonian Basin and the neighbouring Alps we have investigated electromagnetic induction features of two significant tectonic lines in frames of several projects: (1) The Balaton line as the continuation of the Periadriatic line, which separates the Eastern- and the Southern Alps, characterised by granitic intrusions and andesitic volcanism; (2) The Mid-Hungarian line, representing the boundary of two microplates of the Pannonian Basin, namely of the Alcapa and the Tisia. Along the Periadriatic line, in Austria we detected a characteristic orientation (channelling) of the telluric field, which might be related to the geodynamics of the Adriatic promontory. Along the Hungarian section of the Balaton line the MT soundings indicate significant conductivity anomalies on the CEL7 profile, in the Nagyatd area, and to the South of the Eastern basin of the Lake Balaton. At the same time, according to the MT measurements, the Mid-Hungarian line seems to be more intermittent than the Balaton line, although its tectonics can be clearly detected in the MT anisotropy throughout Transdanubia, even to the surroundings of the Paks nuclear power plant. Earthquakes observed in the neighbourhood of these tectonic lines are manifestations of a present geodynamic activity.

Keywords: magnetotellurics, pannonian basin, lineaments

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

JAS002 **Poster presentation** **337**

Inversion of the geomagnetic induction data from EMTESZ experiments by stochastic and linearized thin sheet inversion.

Dr. Vaclav Cerv
geoelectrical Geophysical Institute IAGA

S. KOVACIKOVA, M. MENVIELLE, J. PEK, EMTESZ Working Group

Long period induction arrows and horizontal inter-station geomagnetic transfer functions obtained in the EMTESZ experiments in Pomerania, north-west Polen, were inverted by the Monte Carlo Markov chain stochastic method in a bimodal thin sheet model approximation, as well as by a linearized unimodal thin sheet inversion. From the stochastic inversion with the thin sheet situated at the surface of the Earth, we obtained histograms for unknown conductances in a mesh of 20x20 km cells across the whole area, and inferred the most probable regional conductance model. Results of the MCMC are compared with the results of those of the linearized unimodal thin sheet inversion with the sheet placed at the depth of 3 km. The resulting models are compared with the surface distribution of the conductance of the sedimentary cover.

Keywords: tesz, mcmc, inversion

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

JAS002 **Poster presentation** **338**

Paraguay Belt Conductivity Anomaly: A fundamental tectonic boundary of the South American platform imaged by electromagnetic induction surveys

Dr. Antonio Padilha
Division of Space Geophysics INPE IAGA

Mauricio S. Bologna, Marcelo B. Padua, Icaro Vitorello, Franois H. Chamalaun

Transient geomagnetic variations recorded by an array of 203 stations are analyzed to infer the configuration of internal induced currents in central-eastern part of the South-American platform. Real induction arrows indicate a strong current concentration close to the north-northwest end of the array. A curved 600 km-long crustal conductor running parallel to the structural contour of the Paraguay belt (in center-west Brazil) is defined through 3D forward modeling. A nearly E-W magnetotelluric profile was carried out crossing the conductive anomaly and 2D inversion of the TM mode modeled a strong upper-to mid-crust conductor (conductance larger than 10,000 S). From the high conductivity of the anomalous structure, its observed geometry and surface rock exposures, the most likely interpretation of its source is graphitized biogenic material in metasediments, now deeply underthrust in a Neoproterozoic or Early Cambrian suture zone. This result strongly supports the hypothesis that the collision between the Amazon plate and the western Paran block has probably closed an ocean in the belt region, contrary to former propositions of an ensialic evolution for this belt.

Keywords: south america tectonics, continental accretion, electrical conductivity

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

JAS002 **Poster presentation** **339**

The Speed Field models of Chinese Continent Established by GPS Observations

Dr. Yibin Yao
IAG

In the first time a large covered and valuable speed field model of Chinese continent is established by Multi-quadric equations interpolation method with GPS observations. With which the crustal movement patterns of horizontal are obtained. It provides some practicable, symmetrical and valuable information for the area that GPS have not involved. This will bring active effect on the analysis of regional deformation especially for the study in choosing deformation research area. The present-day vertical crustal movement velocity image of is also expressed by GPS observations, from which we can known the crustal vertical movement patterns. It shows that the research of vertical deformation with GPS in a large area is feasible. All these can cause us study the dynamic movement and dynamics mechanism of continent blocks better. Generally Speaking, the eastwardly movement trend of continent is quite evident, and there is a trend of clockwise rolling, from northeast to east, then to southeast. At the same time continent movement show the difference between east and west. In the west the trend is move towards the north and northeast, while in the east the trend is creep towards south and southeast, with a huge north dextral shear zone. The horizontal movement velocity approximately equals to 30-50mm/a. From the velocity isolines image and dyeing image, the characteristic of vertical crustal movement in Chinese mainland is qualitative analysed: more than 70% of Chinese mainland are descended and the speed of descend is less than 20mm/a , the Qingzang plateau、Huabei plate(excluding Beijing area) and Yanshan plate are ascended with the speed less than 15mm/a. The holistic vertical crustal movement of West-North and East-South、West-South and East-North areas of China are shown an approximate slanting symmetry state. The bearing and grade of the continent plate by GPS observations are in accordance with those by leveling observations, with difference in one or two areas, mainly the difference in Huanan plate. This difference should be attributed to the limitation of GPS vertical precision and the amount of high precision GPS points.

Keywords: multi quadric equations, speed field model, crustal movement pattern

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

JAS002 **Poster presentation** **340**

EM sounding of the lithosphere in the trans-european suture zone (NW Poland and NE Germany)

Prof. Tomasz Ernst
Magnetic Department Institute of Geophysics, Polish Academy of Science IAGA

Waldemar Jozwiak, Anne Neska, Heinrich Brasse, Anja Kreutzmann, Nikolay Palshin, Elena Sokolova, Ivan Varentsov, Laust Pedersen, Maxim Smirnov, Vaclav Cerv

A large-scale international electromagnetic experiment named EMTESZ has been carried out in NW Poland and NE Germany. Its main goal was to study the deep conductivity structure across the Trans European Suture Zone (TESZ), which is the most prominent tectonic boundary in Europe, constituting a complex transition between southeast European Paleozoic Platform and northeast Precambrian Craton.EM measurements were carried out mainly along seismic profiles P2, LT-7, and LT2 crossing the suture zone and running to north-eastern direction. The 2001-2005 field campaigns resulted in a collection of a very large amount of EM data. Impedances, tippers and horizontal magnetic transfer functions have been estimated reliably in a period range from 0.003s to 20000s using different processing approaches. Single site and multi-station estimates were calculated providing sufficient suppression of DC train effects and other industrial noise.Strike and dimensionality analysis indicate that a preferable geoelectrical strike of N60W common for both profiles can be identified, while the influence of 3D structures is observed too. This common strike direction was used to project and rotate all transfer functions.At this stage 2D inversion has been carried out for the two profiles LT7 and P2 using three different approaches. Despite of differences in the resulting models, caused by different parametrization and a priori models, some major common features can be identified. First 3-D inversion results show a segmentation of the Polish Trough. The Cenozoic-Mesozoic sedimentary cover, reaching depths up to 3 km, contains large amounts of saline, conductive fluids. The conductive anomaly in the central part of TESZ in the Polish Trough at the mid crustal depth is well resolved, but its geometry and lateral as well as vertical extensions are not yet clear.The upper mantle of the Precambrian Craton is more resistive than the younger Paleozoic lithosphere by at least one order of magnitude.

Keywords: magnetotellurics, suture zone, 2d inversion

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

JAS002 **Poster presentation** **341**

The extension of the Emtesz-Pomerania Em sounding array towards the Baltic Sea.

Dr. Waldemar Jozwiak
Geomagnetism Institute of Geophysics Polish Academy of Sciences IAGA

Anne Neska, Tomasz Ernst, Heinrich Brasse, Lars Houpt, Anja Schafer, Elena Sokolova, Ivan Varentsov

The international EMTESZ-Pomerania electromagnetic sounding project is an integrated study of the geologic structure and the tectonic role of the Trans-European Suture Zone (TESZ) on the basis of electromagnetic methods. The TESZ is a fundamental tectonic boundary in Europe separating the Precambrian Craton in the North-East from the Variscian Platform in the South-West. The main task of EMTESZ-project was to investigate the geoelectrical structure along seismic profiles P2, LT7, and LT2 crossing the Polish Basin. Here we discuss the recent (2005-06) extension of the EMTESZ-Pomerania electromagnetic sounding array from these initial profiles towards the Baltic Sea, where the rather simple and straight lineament of the Teisseyre-Tornquist Zone (TTZ, the polish part of the TESZ) splits into various tectonic lines and elements. This extension consists of ten Polish deep MT sounding sites on the NW Polish mainland, three Polish sea bottom MV stations in the Baltic Sea itself, and two profiles through NE Germany and Scania () composed of about 30 German deep MT sounding sites. This array covers also the islands of Bornholm, Usedom, and Rgen. The joint array view on the estimated transfer functions (TF) like induction arrows, perturbation vectors, and several invariants demonstrates a prominent change in the strike direction of the dominant deep structures from ~60 NW beneath the seismic profiles in the Polish Basin to almost 90 W in NW Poland, which coincides with the direction of the North-German Basin. There are hints that this change could be connected with a splitting of the TTZ anomaly beneath the Baltic Sea. This means that the data set as a whole cannot be explained by 2D-models alone and that some at least qualitative 3D-approach will be necessary to understand the conductivity structure of this region. The comparison of TF data pseudo sections along the initial P2 and LT7 profiles and a new one connecting land and shelf sites from 2005-06 points to shallower depths for crustal conductivity anomalies at the latter one. The further comparison of 2D inverted geoelectric models along these profiles outlines in detail specific changes in geoelectric sections in the NW direction. The main questions raised by this study are the linkage of the traced conductivity anomalies with the adjacent conducting structures of the North-German Basin and the nature of a high conductive anomaly running roughly along the coast of the NE German - NW Polish mainland.

Keywords: magnetotellurics, marine em, inversion

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

JAS002 **Poster presentation** **342**

Deep electrical conductivity structure across the trap covered volcanic plugs in Saurashtra

Prof. T. Harinarayana
National Geophysical Research Institute, Hyderabad Scientist IAGA

D.N.Murthy, M.Someswara Rao

Mesozoic sediments buried underneath the thick pile of Deccantraps in Saurashtra region has been a challenging geophysical exploration problem. The thick trap cover varies over the large area and conventional seismic methods pose difficulties in exploring the subsurface. Magnetotellurics (MT) comes in a great way to provide an effective solution here. The method uses natural electromagnetic spectrum for reaching deeper subsurface levels. The method is effective because the buried layer has a marked resistivity contrast with the underlying basement. MT aims at determining the subsurface electrical structure over a large depth range. There are regions belonging to very thick trap thickness of more than 3 km, located close to volcanic plugs like Junagadh, Porbandar, Alech, Palitana, Vallabhipur. The region over the volcanic plugs is characterized by thick pile of subsurface basaltic material with thickness amounting to several kilometers, extending down to the deep crust. A number of exposed volcanic plugs/vents in the southern saurshtra peninsula and fairly thin similar structures near the western coast are also reported. These volcanic plugs/vents play a significant role in the tectonic settings of the saurashtra region. MT measurements have been carried over this area for mapping the electrical conductivity below the region. Data acquired along 120 km profile along Porbandar-Junagadh and Sardar-Mangrol with a station interval of 7 km is analyzed here to map the deep conducting features.

Keywords: magnetotellurics, volanic plugs, saurashtra india

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

JAS002 **Poster presentation** **343**

Second-order magnetic phase transition in the Earths crust: reality or fiction?

Mr. Jnos Kiss
Mapping department Etvs Lornd Geophysical Institute

Lszl Szarka, Ernő Prcser, Antal Dm, Antje Franke

According to theoretical considerations and recent physical experiments the so-called second-order magnetic phase transition (the transition between ferromagnetic/ferrimagnetic and paramagnetic states of the material at the Curie/Nel temperature) may accompany with a very sharp enhancement of the magnetic susceptibility. Since the time that Kiss et al. (2005, GRL, 32, L24310, doi:10.1029/2005GL024199) on basis of geomagnetic, geothermic and magnetotelluric considerations suggested this phenomenon occurring in the Earths crust (usually at mid-crustal depths, depending on geothermal conditions and on the type of magnetic material), several pro and contra arguments have been emerged. We present some related modelling results (geomagnetic and electromagnetic induction ones), summarize the arguments of opponents from rock physics, and discuss some related new ideas of experimental and theoretical physicists about such critical phenomena. Several geomagnetic- and conductivity crustal anomalies, where the magnetic phase transition might play role, will be also presented. A special attention is paid to comparison of magnetotelluric results obtained by various codes, incorporating magnetic permeability (e.g., Prcsers code 2006, then the codes by Rijo L. 2003, 8th Workshop, Brazilian Geophysical Society; Cao, J. et al. 2004, 6th China International Geo-electromagnetic workshop, Extended abstracts, pp. 5-8, and Franke A. et al. 2006, 18th EMIW, paper S3-13).

Keywords: magnetotelluric, geomagnetic, phase transition

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

JAS003 **344 - 357**

Symposium
Distribution of water and heat in the crust: Indication from EM studies

Convener : Prof. Yasuo Ogawa

The symposium will focus on recent studies on the crustal and upper mantle structures in active tectonic settings. We welcome studies on the regions of high heat flow, high seismicity and active deformations. In particular, studies on the volcanic and geothermal areas and active fault zones are welcome. Emphasis should be put on the relations with fluids and heat and comparison with other geophysical techniques, such as seismology, crustal deformation, and geochemistry are encouraged

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

JAS003 **Oral Presentation** **344**

Delineation of subsurface structures and tectonics of hot spring, Central Sinai, Egypt, as deduced from magnetotelluric and magnetic data

Mr. Mahmoud Mekkawi
Geomagnetism and Geoelectric National Research Institute of Astronomy & Geophys

Mohamed Elsaid Elbohoty

An intensity study has been performed for Hot Spring, central Sinai, in order to illustrate the role of magnetotelluric and magnetic interpretation in the detection of major subsurface tectonic structural elements affecting both the sedimentary section and the underlying basement complex. More attention was given to the Hot Spring to spot more light on the subsurface structural features that control the behavior of this spring. For the execution of this investigation, the authors carried out magnetotelluric profile with about 10 km distance, in which the Hot Spring is located at the middle of the profile. Magnetotelluric components have been recorded simultaneously during two weeks of measurements. According to the results, the area is tectonically active and there is a conductive anomaly situated just beneath the hot spring at a depth of 2.0 km. The modeling revealed that, a possible connection between this anomaly and the conductive sediments, which can be considered as the source of the phenomena. Aeromagnetic and land magnetic were carried out along several profiles crossing the Hot Spring The necessary reduction concerning the daily variation, the regional gradient and the time variation were applied, and then the total intensity anomaly maps were reduced to the magnetic pole (RTP). This step was followed by application of the filtered and 3-D Euler deconvolution techniques. The results of magnetic interpretation revealed that, the Hot Spring is tectonically controlled by faulting having a major NW-SE alignment and extends to a depth of about 2.0 km. The strong magnetic anomalies surrounding the Hot Spring can be attributed to the occurrence of subsurface basic intrusion of high magnetic content. Also the study revealed that, the area has been affected by two main tectonic trends taken the direction NE-SW and NW-SE. The depth estimation to the basement complex indicated that, the basement ranging between 1.0 km m and 2.0 km, and volcanic basaltic intrusions & dykes between 200 m and 500 m.

Keywords: hotspring, magnetotelluric, magneticdata

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

JAS003 **Oral Presentation** **345**

New laboratory measurements of Vp, Vs and electrical conductivity to unravel the deep crustal anomaly in the Alborn Domain (SE Spain)

Dr. Fabio Ferri
Geosciences University of Padova

Bernardo Cesare, Luigi Burlini, Frank R. Schilling

In the Alborn Domain (Southern Spain) multiple geophysical anomalies (high electrical conductivity, low seismic velocities and high heat flow) suggest the presence of partial melts at deep crustal levels (Carbonell et al., 1998; Pous et al., 1999). This is further supported by the recovery of restitic lower crustal xenoliths retaining evidence of partial melting (Zeck, 1968). These samples offer a unique possibility to determine the influence of melt on the petrophysical properties.The present study is focused on the compressional-waves, shear-waves and electrical conductivity at high pressure and temperature of five metapelitic xenoliths collected from the Neogene dacites of El Hoyazo and Mazarrn (SE Spain). The paragenesis is represented by garnet + biotite + sillimanite + plagioclase + graphite cordierite spinel coexisting with widespread rhyolitic melt as inclusions and interstitial glass (Cesare & Gmez-Pugnaire, 2001) and developed during regional anatexis at 850-900C and ~ 500 - 700 MPa (Cesare et al., 1997).For each sample three mutually orthogonal cores (X, Y, Z) were drilled parallel to the macroscopic fabric elements: X was parallel to lineation and Z normal to foliation.Measurements on Vp and Vs were carried out with the pulse transmission technique in an internally heated gas apparatus (Paterson rig) up to 950C and 500 MPa. The conductivity experiments were performed in a gas apparatus with Ar as pressure medium and similar conditions. An authomated impedance spectrometer was used to collect the resistivity values in the range 1-105 Hz in a two-pole arrangement.After softening and remelting of the interstitial glass, further melt was produced within the interval 900-950C at 0.5 GPa where the seismic signals abruptly attenuated and new minerals grew. The pressure-temperature values and the run products are in good agreement with the anatexis conditions estimated by Cesare et al. (1997).At melting, average Vp is ~6.3-6.5 km/s which is in agreement with the seismic profiles in the area (Carbonell et al., 1998), Vs is ~3.4 km/s and Vp/Vs=1.85-1.91. Moreover the correspondence between magnetotelluric surveys (Pous et al., 1999) and measured conductivity is achieved at T > 800C.The combination of these data suggests that partial melting is a plausible explanation for the regional anomaly and adds constraints to the geothermal structure and the geodynamic significance of the lithosphere in the area.REFERENCESCarbonell R., Sallars V., Puos J., Daobeitia J.J., Queralt P., Ledo J.J. and Dueas G. Tectonophysics, 288: 137-152, 1998.Cesare B., Salvioli Mariani E. and Venturelli G., Mineral. Magaz. 61 (1): 15-27, 1997.Cesare B. & Gmez-Pugnaire M. T., Phys. Chem. Earth (A), 26 (4-5): 255-260, 2001.Pous J., Queralt P., Ledo J.J., Roca E., Garcia X. and Marcuello A. Rev. Soc. Geol. Esp. 8; 513-518, 1999.Zeck H.P., PhD thesis, 1968.

Keywords: experimental, seismic properties, electrical conductivity

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

JAS003 **Oral Presentation** **346**

Radiowave technology for 3D-geoelectrical study of water-bearing pay horizons in oil fields and thawing - water seepage zones in permafrost massif

Dr. Viatcheslav Istratov
RADIONDA Ltd Privat company IAGA

Kuchmin Alexei Olegovich, Lyakh Ekaterina Viktorovna

Radio wave geoinroscopy of inter-well space (RWGI) - way of visualization of an internal structure of geological media in space between wells. A physic-geological basis of a method is the dependence of intensity of absorption of energy of radio waves by the rocks located on a line of distribution of a wave, from the electrical characteristics of these rocks: specific electrical resistance (r) and permittivity (e). The rocks having lower values of r and(or) e, are characterized by higher absorption of radio waves. Using an electromagnetic field in a range of radio frequencies, special technique of measurements and data processing, with homographic image methods or wave restoration methods it is possible to detect and locate in inter-well space geological heterogeneity of relatively small sizes.The borehole equipment was designed and produced by "Radionda Ltd" for detailed studies and measurements of harmonic electromagnetic field intensity at fixed frequencies. The equipment includes special receiver and transmitter supplied with electric dipole antennas, which are lowered into two adjacent holes on a single logging cable each. To exclude antenna effect of the cable, the instruments in the boreholes are provided with independent source of power; they are connected to the cable through dielectric inserts with an optical channel and units of opt electrical transducers. Both receiver and transmitter have processor and ADT (automatic digital transducer), that allow carrying out two-sided exchange of information with surface: to transmit the data of measurements to the surface and to receive the control instructions. Besides measurements of the electric field at the reception point and those of current in the transmitting antenna, such a concept of the equipment structure allows performing a remote matching of the borehole antenna with transmitter and to control and stabilize of the transmitter radiation power and mode. It is worth noting that digital filtering (and special processing, if necessary) of measured signal ensures accuracy and reliability of measurements under conditions of high level of electromagnetic interference.Cross hole and single borehole radio wave testing have a great potential in determining of electrical resistance and permittivity of permafrost formations in situ for detecting thawing zones and seepage process. We discuss peculiarities of temporal and spatial changes in frozen soils that are primarily conditioned by constitutional ice - pore solution transformations. During these transformations all physical properties of frozen medium change, the most sensitive of which are electrical and mechanical. In order to get reliable control and to forecast situations in permafrost areas, an application of other geophysical techniques, primarily electromagnetic and seismic-acoustic in addition to traditional borehole temperature observations, is required. In the paper examples of successful use of two non-standard geophysical methods are presented and discussed: borehole radio wave techniques (profiling, cross-borehole testing etc.) and shallow seismic survey (especially using transverse waves) to study and monitor changes in the permafrost environment in Western Yakutiaunder external technogenic impact. This technology offers to localize in cross hole underground space the thawing-seepage zones under influence of reservoirs.With integrated methods of inductive logging and one-down-hole radiowave raying test the temporary variation of 2 electric characteristics of the section are evaluated: electric resistance (r) and permittivity (e). These data gives the basis for a conclusion about dynamics of the process of a flooding of the main layers, adjoining to well bore, and layers with residual oil saturation. The mining of a field by systems with a flooding, i.e. method of injection in oil seams of water, at irregular porosity and permeability of carbonaceous headers results in

a rather quick flooding of a considerable proportion of reservoir, slashing profitability of oil extracting. In these conditions a major problem is control of displacement process of oil by water, both in space, and in time. The process of displacement of oil by water should be reflected in variation of electric formation characteristics of a header: specific electric resistance (r) and relativepermittivity (e). At inflow in oil reservoir bed a of mineralized (strata) water, its resistance will sharply be depressed, and at inflow fresh (industrial) water - the variation r will be less considerable. Thus the displacement of oil by fresh or salt water should be described by growth of permittivity. Like illustration of possibilities of a RWGI method the materials of measurements held on one of oil-fields of Perm Kama River area (Volga-Ural region) are presented. Presented technology can be applied for monitoring of fluid regime in hot-dry rocks study.

Keywords: radiowave method, cross holeobservations, fluids

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

JAS003 **Oral Presentation** **347**

Resistivity as tool for geothermal exploration and case-histories from Italy and Iceland

Dr. Adele Manzella
Istituto di Geoscenze e Georisorse CNR IAGA

Geothermal resources are ideal targets for electromagnetic (EM) methods since they produce strong variations in underground electrical resistivity. In thermal areas, the electrical resistivity is substantially different from and generally lower than in areas with colder subsurface temperature. The resistivity is affected by the vertically ascending, hot mineralised waters or vapours that originate from the contact between groundwater and high temperature intrusive magmas. Resistivity in geothermal areas is also governed to a great extent by the presence of hydrothermal alteration products, since they contain clays. The zoning pattern is generally governed by the thermal structure, i.e., temperature is the major control on clay mineralogy. The resulting resistivity is related to the presence of clay minerals, and can be reduced considerably when the clay minerals are broadly distributed, such as in volcanic geothermal areas like Iceland. Where permeability is created by a few main fractures and faults, such as in Italy, alteration minerals are localized, and the change in resistivity remains linked in the most parts to the presence of hydrothermal fluids and partial melts. This proved to be true even in presence of steam-dominated geothermal reservoirs in Italy.Resistivity distribution provide clear indication of the presence of hydrothermal fluid flow, and is often considered an important tool to locate geothermal reservoirs. However, resistivity must be always considered with care. Experience has shown that in volcanic rocks the apparent one-to-one correlation between low resistivity and the presence of fluids is not correct, since alteration minerals may produce comparable, and often higher reduction of resistivity with respect to that determined by main fluid flow. As a result, low resistivity anomaly by itself does not always imply that the hydrothermal circulation is present, but rather that it has been active and has produced extensive alteration, although it is not possible to define whether it is still active. This means that the resistivity pattern is frozen-in and does not change when the system cools down or fluid circulation disappears due to sealing effects.On the other end, in crystalline rocks hydrothermal fluid flow even in steam-dominated systems produce strong effects on resistivity distribution, and can be used to directly map the presence of fluids.In conclusion, resistivity proves to be the most sensible physical parameter to geothermal fluid circulation and its effects on underground rocks.Examples from Iceland and Italy provide a clear evidence of what has been discussed so far.

Keywords: resistivity, geothermal

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

JAS003 **Oral Presentation** **348**

Correlations of resistivity structure, seismicity and deformation from some case studies in Japan

Prof. Yasuo Ogawa
Volcanic Fluid Research Center Tokyo Institute of Technology IAGA

Distribution of fluids is important in the framework of the earthquake generation processes (e.g., Sibson et al., 1988; Iio and Kobayashi, 2002). Recent magnetotelluric studies have shown that the brittle ductile boundary often corresponds to the top of the mid-crustal conductors (e.g., Ogawa et al., 2001; Mitsuhata et al., 2001) and have suggested that the fluids distribute under the brittle-ductile boundary over the seismically active regions. An active fault segment at the northern Itoigawa-Shizuoka tectonic line (ISTL),

Keywords: resistivity structure, seismicity, deformation

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

JAS003 **Oral Presentation** **349**

Multidisciplinary approach coupling high resolution electric resistivity tomography, self-potential, temperature and CO2 soil degassing on Stromboli and Vulcano Islands

Dr. Anthony Finizola

Earth Sciences - Universit de la Runion Institut de Physique du Globe de Paris IAVCEI

Revil Andr, Piscitelli Sabatino, Rizzo Enzo, Ricci Tullio, Angeletti Bernard, Barde Cabusson Stphanie, Bennati Laura, Byrdina Svetlana, Carzaniga Nicol, Crespy Agns, Di Gangi Fabio, Mocochain Ludovic, Morin Julie, Rossi Matteo, Roulleau Emilie, Sortino Fr

Finding the geometry of preferential fluid circulation in an active volcano is an important task in the purpose of evaluating the risks associated with phreatic or phreato-magmatic eruptions and possible volcano destabilization processes. Numerous profiles combining high resolution Electrical Resistivity Tomography (ERT), self-potential (SP), soil CO2 flux and concentration and temperature measurements, covering large part of Stromboli volcano and the whole La Fossa cone of Vulcano Island, have been performed from May 2004 to October 2006. The results obtained from the different methodologies (using a maximum spacing of 20 meters) allowed identifying the main structural boundaries and associated fluid circulation structuring the shallow architecture of Stromboli volcano and La Fossa cone. The hydrothermal system has been clearly identified by very low values of the ERT and by CO2soil degassing, SP and temperature anomalies on both volcanoes. Moreover, on Stromboli volcano, an unknown collapse structure has been also clearly highlighted by ERT and SP measurements. The results obtained using this multidisciplinary approach for the first time through an entire volcanic edifice, reveal the very high potentiality of the adopted methodologies to determine preferential fluid flow pathways and main structural boundaries and, thus, to contribute both to fluid and structural modelling, hazard evaluation, and locate strategic sites to install permanent fluid monitoring stations.

Keywords: stromboli, vulcano, multidisciplinary

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

JAS003 **Poster presentation** **350**

Interpretation of self-potential anomalies on Usu volcano, Japan

Dr. Hideaki Hase
Institute of Seismology and Volcanology Hokkaido University IAVCEI

Takeshi Hashimoto, Yasunori Nishida, Mitsuru Utsugi, Hiroshi Inoue, Mizue Saba

We conducted self-potential (SP) surveys on Usu volcano since July to December 2006. The compiled SP map reveals positive anomalies around Ko-Usu lava dome and at the foot of the volcano without northwestern part of the volcano, and a negative anomaly on the top of O-Usu lava dome. The SP profile on the summit caldera shows the same pattern of 1985s. However, the peak-to-peak amplitude of the SP value is different: the 1985s of that shows 1000 mV while the 2006s shows 1400 mV. Topographic effect is clearly shown along the southwestern flank of the volcano, in which coefficient is about -2.5 mV/m. We corrected the SP profile using this coefficient in order to remove the SP associated with subsurface gravitational groundwater flow into the volcano. The corrected SP map reveals a large and extensive positive anomaly over +600mV and several local positive anomalies over +1000 mV on the summit caldera. These anomalies are likely to be affected by an extensive altered layer and hydrothermal upwelling beneath the summit caldera, respectively. The corrected SP also reveals a clear positive anomaly on the ridge of Usu-Shinzan cryptodome. This anomaly is not regarded to be formed by hydrothermal upwelling, because any indications of fumarolic and geothermal activities have not seen on the ridge of the Usu-Shinzan for the moment. The SP anomaly may be affected by the intruded substance into the Usu-Shinzan. The 2000 eruption of the Usu volcano was occurred at the northwestern flank of the volcano on 31 March 2000. Since fumarolic and geothermal activities have been continuing after the eruption, we expected that a positive SP anomaly associated with hydrothermal upwelling was observed there. However, the SP profile shows no significant anomaly there. Additionally, the SP amplitude in the area is very small in spite of rugged topography (i.e. we can not recognize the topographic effect around the area). We recognized that an extensive low resistivity layer (< 10 ohm-m) located in the shallow part into the area shields the SP variations such as hydrothermal upwelling and/or topographic effect.

Keywords: self potential, usu volcano, streaming potential

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

JAS003 **Poster presentation** **351**

In search for the electrical conductors at the fault zone of North Anatolian Fault in Turkey by audio-frequency magnetotellurics

Dr. Sabri Bulent Tank
Geophysics dept. Bogazici University IAGA

Yoshimura Honkura, Yasuo Ogawa, Mustafa Kemal Tuncer, Masaki Matsushima

Audio-frequency Magnetotellurics (AMT) surveys were performed in order to investigate the shallow electrical resisitivty structure near the western part of the North Anatolian Fault (NAF) along three distinct north-south alligned profiles, each having 10 stations. First profile AMTa crosses the northern branch (Izmit-Adapazari segment) of NAF on which Izmit earthquake took place on 17 August 1999 and profiles AMTb and AMTc cross southern branch (Iznik-Mekece segment) of NAF which is a seismic gap. Groom-Bailey decomposition was applied to check the two-dimensionality of the AMT data at the study area. Following the tensor decomposition, two dimensional inversions were applied using the code developed by Ogawa and Uchida (1996) for three profiles. The resulting models that are based on the TM and TE modes suggest that the North Anatolian Fault has a sharp lateral contrast in electrical resisitivity that may be acting as a barrier for fluid flow.

Keywords: magnetotellurics, izmit earthquake, fluids

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

JAS003 **Poster presentation** **352**

Two-dimensional inverse modeling of magnetotellurics data at Duzce fault, Turkey

Dr. Sabri Bulent Tank
Geophysics dept. Bogazici University IAGA

Mustafa Kemal Tuncer, Igor Rokityansky, Tulay Kaya, Timur Shavchenko

Magnetotelluric (MT) surveys were carried out along two profiles crossing the fault rapture zone associated with the Duzce earthquake, which took place on 12 November, 1999 in the western part of the North Anatolian Fault Zone (NAFZ). In this study by constructing two north-south alligned profiles, we focus on the east and west parts of the epicenter where during the earthquake occurrence the rupture velocity variedassupershear in the east to sub-Rayleigh in the west. By performingtwo-dimensional inverse modeling ofE-polarization, H-polarizationand transfer functionmagnetotellurics data we aim at resolving the electrical resistivity structure and its relations to the seismic properties of the study area.

Keywords: magnetotellurics, duzce earthquake, electrical resistivity

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

JAS003 **Poster presentation** **353**

Post-volcanic geothermal water aquifer near the Slanske Vrchy MTS. (Slovakia), its magnetotelluric investigation and mathematical models

Dr. Jan Vozar
Department of Geomagnetism Geophysical Institute, Slovak Academy of Sciences IAGA

Milan Hvozdara

According to geological setting combined with the knowledge from few drill holes upto the depth 3 km there was discovered the promising reservoir of geothermal water in eastern Slovakia. This aquifer is created by the heating of the groundwater which fill the dish-like depression near the south slope of the Sl nske Vrchy Mts. of volcanic origin, where the volcanic activity finished about 7 My ago. For purposes of assesment the horizontal and depth extension of this reservoir there were performed magnetotelluric investigations, using periods in range 0.025 s to 500 s. The ananlysis of apparent resistivity, phases and interpretation through induction vector enables interpretation of resistivities for upper 3-4 km of the crust and two-dimensional structures for lower depth. The obtained models indicate that the zone of low resistivity corresponding with geothermal anomalous structures was found in all sounding sites and their depth varies from 2000-3200 m. Appropriate thickness of layers bearing the low resistive water is estimated to be 500-1000 m. This magnetotelluric investigation we supplemented also by a 3-D geothermal refraction anomaly model with stationary flow of groundwater, as well as by the 3D electromagnetic induction modeling.

Keywords: geothermal aquifer, magnetotelluric measurement, mathematical modelling

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

JAS003 **Poster presentation** **354**

Resistivity imaging of Tarumai Volcano in Northern Japan

Mr. Yusuke Yamaya
Faculty of Science Hokkaido University IAGA

Takeshi Hashimoto, Toru Mogi, Hiroshi Ichihara

Tarumai is an active volcano in Hokkaido, northern Japan, generated at 9000 years ago as a post caldera volcano after Shikotsu Caldera. The volcano consists of almost pyroclastic materials due to four times of pumice eruption (Soya, 1972). As its most recent volcanic activity, low frequency earthquake swarm triggered by the 2003 Tokachi-Oki earthquake (Mw 8.3), was observed beneath the volcano and gas emission has been activated at some fumaroles in the southwestern part of the summit lava dome (Terada et al., 2004). Aoyama et al. (2004) suggested that hydrothermal water system beneath the volcano might have contributed to these activities. Although it has been expected that such hydrothermal water is found as a conductive body, so far, few studies have been reported on resistivity structure of Tarumai Volcano. In addition, it has been clarified neither the location of magma reservoir nor the magma transfer process by any investigation. The purpose of this study is to detect the location of the magma reservoir or the past magma intrusion, and the development of hydrothermal system beneath Tarumai Volcano. For this purpose, we performed Magnetotelluric survey in this area, and then derived 2-D resistivity image using inversion scheme. Previous to the 2-D inversion, we applied Groom-Baileys decomposition analysis (Groom and Bailey, 1989) to the tensor impedance data to estimate the direction of the electromagnetic strike. The result of decomposition analysis shows the direction N45W or N45E in a period range above 10 sec. We assumed the NW-SE trending strike and rotated the impedance tensors to this direction in this study. This direction is also geographically consistent with the alignment of the post caldera volcanoes (Tarumai, Fuppushi and Eniwa) and with the direction of the maximal stress field due to subduction of Pacific plate. We obtained a resistivity section of NE-SW profile by using a 2-D inversion code developed by Ogawa and Uchida (1996).The resistivity section is characterized by the central conductive column (less than 10 Ohm-m) at depths of 3-8 km below the summit. This column is considered as the altered or heated basement rocks hydrothermal water convection through the volcanic activity. Maekawa et al. (1999) suggested two pressure sources situated at depths of 5.7 km and 10 km from gravity changes. Especially, the pressure source at a depth 5.7 km is situated in the conductive area of our resistivity model. Assuming that this pressure source represents a shallow magma reservoir, the conductive column can be attributed to the hydrothermal alteration along the vent. In the shallower part, an extremely conductive body (a few Ohm-m) was found around the sea level. This conductive body well corresponds to the positive current source of self-potential (Miyamura et al., 1995) and also to the hypocenters of low frequency earthquakes. We also examined a NW-SE section as well as previous analysis to check the structural dimensionality. Comparing the orthogonal sections, NW-SE section is characterized by relatively uniform structure and poorer variation in resistivity, while NE-SW section has more complicated structure with wider range of resistivity. This fact implies the 2-D structure and supports that the NW-SE trending strike was correct.

Keywords: magnetotelluric, resistivity structure, magma reservoir

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

JAS003 **Poster presentation** **355**

Geothermal system of a phreatic eruption environment under Kusatsu-Shirane volcano, implied by three dimensional magnetotelluric modeling

Prof. Yasuo Ogawa
Volcanic Fluid Research Center Tokyo Institute of Technology IAGA

Nurhasan, S. Bulent Tank, Naoto Ujihara, Yoshimori Honkura

Keywords: magnetotellurics, clay, phreatic eruption

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

JAS003 **Poster presentation** **356**

Electrical conductivity structure of the crust and upper mantle in Aershan volcanic area

Dr. Ji Tang
Research Division of Geophysics Institute of Geology,China Earthquake Administrati IAGA

Wang Jijun, Zhao Guoze, Zhan Yan

Magnetotelluric (MT) measurement has been carried out at 7 sites along a profile in NNW direction in Aershan active volcanic area, in NE China. The result obtained 2-D inversion shows that two volcanic zones, the older and younger volcanic zones with their magma conduits down to depth, exist in the study area. Of them a newly found younger active volcanic zone still maintains its higher temperature state at depth of 10-12 km, where may exists an abundant fluid, and a conduit for supplying heat from the mantle to the crust exists at depth of 30~50 km. But a magma conduit being in cooling may exist down to depth of 30 km beneath the older volcanic zone. The two volcanic zones may have the same resource at depth.

Keywords: aershan volcano, magnetotelluric, magma conduit

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

JAS003 **Poster presentation** **357**

Seafloor Electromagnetic Observations off Tottori in the Sea of Japan

Dr. Takafumi Kasaya
IFREE JAMSTEC IAGA

Hiroaki Toh, Masashi Shimoizumi, Ichiro Shiozaki, Ryokei Yoshimura

Seafloor electromagnetic observations were made off Tottori in the Sea of Japan together with MT measurements in the land region, in order to investigate the rsistivity structure in the San-in region, the Tottori and surrounding region in the northern part of Chugoku district, southwestern Japan, where epicenters of microearthquakes are remarkably distributing within a line belt with a width of about 4-9 km along the coastal line of the Sea of Japan. The depths of the hypocenters are located up to about 10km depths. In the seismic belt, several large earthquakes of M6.2-7.4 took place in 1943, 1983 and 2000. Moreover, quaternary volcanoes, such as Daisen volvano and Oginosen volcano are also located in the seismic belt. Recently, the relationship between the pore fluid and the occurrence of the earthquake has been discussed. The resistivity structure is very sensitive to the existence of the pore fluid. It is reported that the seismogenic zone agree with the resistivity boundary and high resistivity area where nearby the very lower resistivity zone (Mitsuhata et al., 2001; Kasaya et al., 2002a).We have carried out wide-band MT observations along many survey lines across the seismic belt mentioned above, to investigate heterogeneity in the crustal electrical resistivity structure. Shiozaki et al. (1999), Shiozaki and Oshiman (2000), and Kasaya et al. (2002b) found the low resistive region beneath seismogenic zone of the high seismicity belt on each MT profile line, and that the upper resistive crust corresponds to the seismogenic zone in the Tottori and northern Hyogo region. The low resistive region found along each MT profile seems to form a conductive zone extending in the almost E-W direction beneath the seismic belt extending in the almost same direction of the conductor. This result strongly suggests the existence of crustal fluid beneath the seismogenic zone in the focal area.On the other hand, the survey lines should be extended and longer period MT data should be obtained, in order to investigate deeper resistivity structure and clarify the relationship between subducting Philippine Sea plate and the deeper resistivity structure beneath the San-in region. Therefore, we carried out seafloor and land MT surveys. It is important to analyze both data sets to obtain high accuracy resistivity strucure (Kasaya et al., 2005; Toh et al.,2006).We used three types of OBE(M)s for seafloor MT survey. One is small-sized OBEMs, and has been developed by JAMSTEC (Kasaya et al., 2006) with the capability of makeing high-frequency EM recordings with 8 Hz sampling rate. This OBEM measured three magnetic components with fluxgate magnetometers and two horizontal components of electric field. The next OBE is also small sized instrument, has been developed by Kyusyu polytechnic college. Another one is Long-Term OBEM, and this also can measure three components of magnetic-field variations with fluxgate sensors and two horizontal components of electric field variation. Four OBEMs and one OBE were set up along 150km survey off Tottori prefecture, using Wakatori-maru which is the Tottori prefecture high school vessel. Three small-sized OBEMs of JAMSTEC (Kasaya et al., 2006) were recovered by the KT06-25 cruise. LT-OBEM will be recovered in August 2007. On land, MT measurements were started before deployment of OBEMs and OBE, and still have been continued. In this presentation, we will discuss the preliminary results, and mention our future observation plan around the San-in region.

Keywords: resistivity, obem, fluid

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

JAS004 **358 - 388**

Symposium
Methodology in EM studies: Theory, modelling and inversion

Convener : Dr. Alexei Kuvshinov

Electromagnetic (EM) studies of the conducting Earth has advanced significantly in the last decade, driven in particular by the progress in the methods for processing, analysis, modelling and interpretation of EM data. We seek contributions illustrating the current state and new opportunities in this field. We welcome the works that deal with various types of EM data both from controlled and natural sources, at different earth scales and levels (including sea-floor and satellite measurements). Works related to three-dimensional (3-D) modelling and inversion are particularly welcome. In addition to theoretical results, we invite examples illustrating the use of new algorithms on real data sets

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

JAS004 **Oral Presentation** **358**

Evidence of fractures from the image of the subsurface in the Akonlinga-Ayos area (Cameroon) by combining the Classical and the Bostick approaches in the interpretation of audio-magnetotelluric data.

Dr. Ndougsa-Mbarga Theophile
Physics Advanced Teacher's Training College, University o IAGA

Meying Arsne, Enyegue--Nyam Franoise, Manguelle-Dicoum Eliezer

Exploitation of audio-magnetotelluric data has been realised by combining the classical and Bostick approaches with the objective to determine the structuration of layers in the Akonolinga Ayos subsurface area. The work has been devoted to the processing and interpretation of audio-magnetolluric data of two profiles respectively Akonolinga-Mengueme and Mbang-Metol which is running approximatively N-S and have nine stations of measurement each over a distance of 35-40 km. These two profiles cover a length of 70 km in the E-W direction. Different representations of data have been used and have shown interesting results. The geoelectric sections derived from these two approaches show the topography of the subsurface with many discontinuities. This topography is presenting a major fault passing between Ngultangan and Olembe and another between Ebale and Envong, both directed E-W. The different geological sections have also been proposed. A discussion of results issued from these two approaches shows that the Bostick approach brings more details in the structuration of layers than the classical one. The combination of the two approaches is necessary for a better interpretation of audio-magnetolluric data as we have realized it during this study.

Keywords: audiomagnetotelluricsounding, classicalandbostickapproach, interpretationfault

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

JAS004 **Oral Presentation** **359**

Charecteristics of geomagnetic storm

Mr. Suaidi Ahadi
Geomagnetic BMG Indonesia IAGA

Geomagnetic Storm in equator and low latitude have impact not too significant if compare with High latitude which direct on view like aurora and deviation declination value too significant. Geomagnetic storm in Equator very interesting for research cause have characteristic whose impact direct couldnt on view. In the Research will looking for Characteristics model Geomagnetic storm in Equator and low latitude with component H,D,Z and F, and using index KP for could correlation Geomagnetic Storm Series with correlation nature phenomenon like telecommunication, Navigation and Seismic Activity, The data using Geomagnetic Observatory in Equator low Latitude which INTERMAGNET groups and addition Data from Geomagnetic Observatory Tuntungan, Tanggerang and Manado in Indonesia. Finally , The research will be really description for Characteristics Geomagnetic Storm in equator and Low latitude and how big impact for Telecommunication, Navigation, Electricity and Seismic Activity

Keywords: modelling, low latitude, equator

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

JAS004 **Oral Presentation** **360**

The parallel algorithms for inverse gravimetry and magnetometry problems solving

Prof. Elena Akimova
Ill-posed problems Institute of Mathematics and Mechanics of UrB RAS IAGA

INVERSE PROBLEMS 1. The three-dimensional inverse problems of gravimetry and magnetometry are investigated. We assume that a model of the lower half-space consists of three mediums with constant densities which are separated by the surfaces S1 and S2 to be determined. In the Descartes coordinate system, the gravimetry and magnetometry equations with respect to the unknown function Z=Z(x,y), which describes the interfaces, are reduced to the two-dimensional nonlinear equations of the first kind. INVERSE PROBLEMS 2. The three-dimensional inverse gravity problems for finding the variable density G=G(x,y) in the horizontal or curvilinear layer (H1, H2) using the gravitational data measured on the ground surface are considered. A priori geological information is known that outside the layer local sources of the gravitational field are absent. Problems 2 are reduced to the linear two-dimensional integral equations of the first kind. Hence, problems 1 and 2 are ill-posed problems. The preliminary gravitational and magnetic data processing is connected with the selection of the anomalous fields from the common data measured on a rectangular areas in some regions in the Ural, Kazakhstan and Orenburg. This processing was implemented by colleagues from Institute of Geophysics of UrB RAS according to P.S. Martyshko and I.L. Prutkins method. PARALLEL REALIZATION. After discretization of the integral equations on the grid, where the right parts are given, and approximating the integral operators by the quadrature formulas, problems 1 are reduced to solving the systems of nonlinear equations, whereas problems 2 are reduced to the systems of linear algebraic equations with asymmetric and full matrices of large dimension. For solving the nonlinear integral equations the iterative regularizing Newton method is used. Thus, at every step of Newton method and for solving problems 2, we have to solve a system of linear equations. For this aim, parallel regularized direct (Gauss, Gauss-Jordan, Square-Root) and iterative methods (Prime Iteration, Steepest Descent, Conjugate Gradients, Minimum Discrepancy and Minimum Error) are applied. Parallelization of the direct and iterative algorithms and their realization has been implemented on the Massively Parallel Computing System MVS-1000 with the MPI Fortran program library. Parallelization of the algorithms is founded on the dividing the solution vectors Z and G into parts and matrices of systems of equations into blocks by the horizontal lines according to the number of processors. Each processor calculates its own part of the solution vectors. The analysis of the efficiency of parallelization of the direct and iterative algorithms with different numbers of processors is carried out. CONCLUSIONS. We have got the same solutions using the different parallel algorithms. The results of calculations show that the parallel algorithms have high efficiency of parallelization. The parallelization decreases significantly the time of solving the problems. The surfaces S1 and S2 obtained by the Newton method and reconstructed density in layer correspond to the real geological perceptions about the Ural, Kazakhstan and Orenburg regions under investigation. Work partially supported by the research project No. 06-01-00116 of the Russian Foundation for Basic Research and Integrated project S-3 with SB and FEB of RAS.

Keywords: gravimetry, magnetometry, parallelization

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

JAS004 **Oral Presentation** **361**

3-D electrical structure of a Kimberlite pipe derived from modeling and inversion of controlled source multifrequency data

Dr. Saurabh Verma
Geophysical Exploration and Modeling National Geophysical research Institute, India IAGA

Kaushalendra M. Bhatt, Shashi P. Sharma

Kimberlites provide the major source rocks for diamonds. When weathered, they make good electrical targets due to formation of conducting clayey minerals like montmorillonite in the topmost regions. Most of the kimberlites intrude the earths crust as pipes or chimneys with outcrops having usually circular or oval cross sections. The size of these outcrops can vary from a few 100s of sq m to several 1000s of sq m and typical size of a mineable kimberlite outcrop may be of the order of 300 m X 500 m. The depth extent of such pipes may be several 100s of meters and weathering provides a gradational variation along the depth of the pipe. The topmost weathered region may extend up to 100 m or more. The weathered kimberlite in this region is yellowish and hence it is called yellow ground. The partly weathered material underneath retains the typical bluish color of kimberlite and is called blue ground while the hard, compact and unweathered material in the deeper regions is called harde bank. Geoelectrically, the yellow ground has resistivity in the range of about 1 ohm.m to a few 10s of ohm.m. This resistivity increases to several 100s of ohm.m in the harde bank. For electrical and electromagnetic exploration, the topmost yellow ground provides a very good 3-D conducting target yielding confined anomaly. Multi-frequency EM data employing dipole-dipole configuration (MAXMIN II), obtained over Pipe 6 in Wajrakarur region, district Anantpur, India, is modeled to delineate the 3-D electrical structure of the pipe. Presence of a thin and heterogeneous overburden layer of weathered black cotton soil with moderate conductivity adversely affects the response at high frequencies. While the lowest frequency yields low amplitudes of real and imaginary components, hardly above the noise level. Thus it is found that the intermediate frequencies provide data suitable for modeling. Initial parameters, obtained by forward modeling are utilized to get the final parameters of the electrically conducting part of the pipe using a 3-D inversion algorithm. Inversion results show good agreement with the results obtained by multi-electrode electrical tomographic imaging and drilling.

Keywords: kimberlite exploration, 3 d em modeling and inversion

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

JAS004 **Oral Presentation** **362**

An area in and around Keonjhargarh,Orissa an ideal window for deeper electromagnetic exploration

Prof. Kalyan Kumar Roy
Dept. Geol.Sci.Jadavpur University,Kolkata.India Emeritus Scientist IAGA

Suman Dey

Magnetotelluric survey,(Sponsored by DST ,Project No.ESS/16/103/98) over Singhbhum granite batholith near Keonjhargarh, Orissa ,Eastern India revealed that thickness of the batholith varies from 20 to 30 km here.Both TE and TM mode modeling gave almost same order of estimate. Resistivity of the batholith is very high.RRI inversion show that the resistivity of the batholith can vary from 30,000 ohm-m to 70,000 ohm-m. MT signals within the period range of 0.25 seconds to 4096 seconds could penetrate deeper inside the earth with lesser attenuation because of very high resistivity of the thick granite batholith and absence of lower crustal conductor and could see the 110 km discontinuity in this area.Rotation invariant parameters,viz., (Rho-determinant(ρD),Phi-determinant (ΦD)),(Rho-central(ρC),Phi-central(ΦC)) and (Rho-average(ρB),Phi-average(ΦB) are better MT parameter for one and three dimensional interpretation because of higher information content.Information from all the off diagonal and diagonal elements of the MT tensor Z are present in both the pairs of parameters (ρD,ΦD),(ρC,ΦC).Information from both the off diagonal elements are present in (ρB,ΦB). Here ρ stands for resistivity and ϕ stands for phase.Roatational invariant(RI) parameters show less scatter and more consistency. Rejected data in convensional TE and TM mode domain changes to interpretable data in RI domain.Since Helmholtz electromagnetic wave equation totally decouples into two sets of equations in 2D TE and TM mode electromagnetics,RI data are not used for 2D interpretation.But 2D stitched in model based on 1D inversion of RI data gave better signature of the 110km discontinuity below Keonjhargarh.Therefore long period MT (LMT) signals with 30,000 to 40,000seconds period may detect the 330 km discontinuity (olivine-spinel transition zone) in this area in future .Because this area is an ideal granite window.

Keywords: magnetotallurics, rotation invariance

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

JAS004 **Oral Presentation** **363**

Innovations in the inversion of quasi-2D MT/MV data sets

Dr. Ivan Varentsov
Geoelectromagnetic Res. Centre Institute of Physics of the Earth IAGA

The efforts to improve the interpretation of joint magnetotelluric (MT) and magnetovariational (MV) data sets in the class of 2D models are discussed. The recent progress in the development of 2D inversion techniques is well seen in a fine convergence of partial and multi-component solutions for complicated synthetic 2D data sets. However, a real data 2D inversion meets the influence of 3D distortions, which cause convergence difficulties and noticeable contradictions between solutions obtained for different data ensembles. Several approaches are examined to overcome 3D distortion effects: - the extension of data error bars depending on skew and strike direction parameters of specific transfer functions to outline (overweight) 1D/2D data elements; - the emphasis on the MV data components, especially the horizontal magnetic responses; - the MT impedance static shift elimination/correction within the inversion, - the use of robust inversion estimators to resolve convergence contradictions; - the robust averaging of models obtained for different data ensembles to outline the mainstream and estimate a scatter in the model space; - the multi-component inversion starting from such average models on the way to final results. The effectiveness of the joint use of these tools is verified on a number of synthetic data sets calculated for quasi-2D and strongly 3D geoelectric structures. Finally, the application of this methodology to the inversion of profile data sets in the EMTESZ-Pomerania array EM sounding experiment is discussed.

Keywords: array em soundings, 2d inversion, 3d data distortions

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

JAS004 **Oral Presentation** **364**

Data Space Conjugate Gradient Inversion for 2-D Magnetotelluric Data

Dr. Weerachai Siripunvaraporn
Geomagnetic Mahidol University IAGA

Gary Egbert

A data space approach to magnetotelluric (MT) inversion reduces the size of the system of equations that must be solved from M M , as required for a model space approach, to only N N, where M is the number of model parameter and N is the number of data. This reduction makes 3-D MT inversion on a personal computer possible for modest values of M and N (Siripunvaraporn et al, 2005). However the need to store the N M sensitivity matrix J remains a serious limitation. Here, we consider application of conjugate gradient (CG) methods to solve the system of data space Gauss-Newton equations. With this approach J is not explicitly formed and stored, but instead the product of J with an arbitrary vector is computed by solving one forward problem. As a test of this data space conjugate gradient (DCG) algorithm, we consider the 2D MT inverse problem. Computational efficiency is assessed and compared to the data space Occams (DASOCC) inversion by counting the number of forward modeling calls. Experiments with synthetic data show that although DCG requires significantly less memory, it generally requires more forward problem solutions than a scheme such as DASOCC, which is based on a full computation of J.

Keywords: magnetotelluric, inversion, data space method

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

JAS004 **Oral Presentation** **365**

Conductivity model of the Dnepr-Donetsk basin, Ukraine

Dr. Svetlana Kovacikova
Geoelectric Geophysical Institute IAGA

Igor Logvinov, Josef Pek, Victor Tarasov

We present a generalized crustal conductivity model of the complicated two-level structure of the shallower conductor of the Dnepr-Donetsk sedimentary basin crossing a deeper conductor of the Kirovograd conductivity anomaly. The long period EM induction data supplemented by a series of MT measurements were used to study the subsurface and crustal heterogeneities within the area of interest. Three different techniques for the EM field modeling are considered in our study. We present 2D modelling, advances in the conductance thin sheet approximation of the regional crustal structure and discuss the projection of 1D inverse anisotropic models on the territory of the Dnepr-Donetsk basin.

Keywords: conductivity, inversion, anisotropy

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

JAS004 **Oral Presentation** **366**

Non-linear Conjugate Gradient Inversion Technique for the Problem of 3-D Global Electromagnetic Induction

Dr. Anna Kelbert
College of Oceanic and Atmospheric Sciences Oregon State University IAGA

Gary D. Egbert, Adam Schultz

We describe a newly developed numerical 3-D inverse solution to the mantle-scale problem of geomagnetic induction with natural sources. Our approach involves solving the regularized least-squares inverse problem using a non-linear conjugate gradients technique. The electrical conductivity of the mantle is parametrized with layered spherical harmonics. We discuss the vertical and horizontal resolution of our method, based on the reconstruction of checkerboard and other synthetic perturbations from magnetic field ratios. We also consider the effect of the frequency range on the resolution of our method. We provide an inverse model for the Fujii & Schultz (2002) low-frequency global observatory data set, discuss the reliability of these results, and describe the limitations of the currently available observatory data sets.

Keywords: inversion, electromagnetic, mantle scale

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

JAS004 **Oral Presentation** **367**

Efficient Inversion of Multi-frequency EM Data: A hybrid conjugate gradients Gauss/Newton algorithm

Prof. Gary Egbert
College of Oceanic and Atmospheric Sciences Oregon State University IAGA

To generate one search direction conjugate gradient (CG) methods used for penalty functional minimization require two solutions per frequency of the governing differential equations. These calculations effectively generate data sensitivities for one linear data contrast for each frequency. By saving the results of these calculations a good approximation to the full Jacobian of the penalty functional can be built up in a comparatively small number of CG steps, allowing use of approximate Gauss-Newton (GN) methods. Using this idea we develop a new algorithm combining elements of the standard CG and 'Occam' minimum structure inversions, which adjust the regularization parameter for step-length control. Tests on synthetic data for a two-dimensional magnetotelluric problem show the method provides essentially the same solutions as those obtained using a GN method requiring full calculation of the Jacobian, but at a fraction of the computational cost. The new approach is also 3-5 times more efficient than the standard CG approach. We will discuss implementation of this and other algorithms for 2D MT within the context of a modular EM inversion system we are using as a test-bed for algorithm development. Progress on generalization to the three-dimensional MT inverse problem will be discussed.

Keywords: inverse methods, magnetotellurics, electromagnetic induction

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

JAS004 **Oral Presentation** **368**

A semi-global inversion of geomagnetic and geoelectric response functions

Prof. Hisashi Utada
Earthquake Research Institute University of Tokyo IAGA

The Earth's deep conductivity distribution in the mantle transition zone or the lower mantle can be studied by inverting long period (several days or longer) geomagnetic and geoelectric variations. Such field variations are mostly excited by fluctuating ring current with induction scale length comparable to the size of the mantle so that the forward modeling has to take both the Earth's sphericity and the source field configuration into account which can be reasonably ignored in regional magnetotelluric modeling. Recently we developed an inversion code that can be applied to global induction problems. We use the modified IDM as a forward solver and the Quasi-Newton method with the BFGS update algorithm for minimizing the objective function. In the forward solver, the heterogeneous 3-D conductivity distribution was expressed by a superposition of a radially symmetric part (the reference model) and lateral perturbation from it. At relatively shorter periods, the conductivity contrast between ocean and land causes significant induction anomaly so that the effect is treated as a priori constraint because the sea floor topography and the conductivity of seawater can be given parameters. As there exists no well-established 1-D reference conductivity model, there is another serious problem how to determine a best 1-D reference model though it is out of the scope of this presentation. This inversion code was applied to a semi-global problem in which global induction approach is taken for studying the conductivity distribution in the mantle transition zone of a part of the Earth. Taking a semi-global approach is simply because presently available observatory distribution is heavily non-uniform. So far, results from two case studies have been obtained and will be presented in this talk: one from the North Pacific Ocean by inverting long period GDS and MT (obtained by submarine cable measurements) responses and the other from Europe by inverting long period GDS responses. For accurate geophysical interpretation of inverted models, spatial resolution and sensitivity were examined by using a checkerboard test and a sensitivity mapping as they are usually done in a seismic tomography. It was obvious we have low resolution and sensitivity where observation sites are sparse, which has to be improved by installing new observation stations where necessary. Using additional information may be effective for the improvement. Here we introduce the horizontal transfer function (HTF) and examine effectiveness as a global induction response function by forward calculation of a checkerboard model. Results showed that the HTF is as sensitive to lateral heterogeneity as the GDS response, though it is essentially insensitive to a radially symmetric conductivity structure. It was also shown that the anomalous part of the HTF has different sensitivity distribution from that of the GDS response, which clearly indicates the HTF works as additional information in a global problem as well as regional/local induction problems.

Keywords: global induction, 3d inversion, mantle transition zone

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

JAS004 **Oral Presentation** **369**

Time-harmonic electromagnetic induction in the spherical multi-layered earth due to coaxial current loops or belts

Dr. Milan Hvozdara
geomagnetism scientific worker IAGA

The paper presents theoretical formulae for calculation of the spherical harmonic expansion of magnetic potential for current loop or current belt model for current systems in the high ionosphere and magnetosphere. The axis of symmetry for the current system may coincide with the axis of Earth's rotation or can be inclined by some angle. The components of individual wave functions for spherical harmonics n=1,2,3, ... are expressed by means of Born-Fock modification of spherical Bessel functions. Special attention is devoted to calculations of electromagnetic response for long-period time harmonic EM field for multilayered spherically concentric conductivity models of the Earth for periods 3.3 hours till 6 years. The calculations of reflection and transmission coefficients on superficial spherical boundaries must be treated especially for thin layers in the oceanic or continental litosphere and upper mantle. Theoretical responses were used for calculation of long-period geomagnetic field distributions for various "normal" conductivity and sources models, separately for continental or oceanic models. The responses at shorter periods are of greater moduli for the oceanic models (because of higher conductivity in the upper layers) which explains the lower vertical and higher horizontal components of magnetic field in comparison to the continental models.

Keywords: em inductionn, spherical multi layered earth, current loop source models

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

JAS004 **Oral Presentation** **370**

Adaptive finite element modeling for Marine EM

Dr. Kerry Key
Scripps Institution of Oceanography University of California, San Diego IAGA

Yuguo Li, Chester Weiss

We present two new finite element (FE) formulations for marine electromagnetic exploration that are part of the MARE2D open source modeling package (Modeling with Adaptively Refined Elements). We use unstructured triangular FE grids, which easily accommodate arbitrarily complex 2D structures. Starting with a coarse grid, we use adaptive grid refinement based on a recently developed goal-oriented a posteriori error indicator to automatically refine the FE grid until the desired level of solution accuracy is obtained. This robust formulation allows for all levels of users (from novice to expert) to obtain accurate EM responses, even from highly complicated structures. We present several examples of both the magnetotelluric and controlled-source EM formulations which illustrate the utility of MARE2D for complex offshore modeling problems.

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

JAS004 **Oral Presentation** **371**

Numerical modelling of motionally induced electromagnetic field in the Japan region

Dr. Ikuko Fujii
Technical Division Kakioka Magnetic Observatory, JMA IAGA

Since Faraday's attempt in the Thames, it has been recognized that a motion of the conductive water through the geomagnetic field causes a dynamo effect and induces electric and magnetic fields. Theoretical considerations on the effect have revealed that the motionally induced electric field mainly reflects a total flux of the sea water and several experimental studies were made to estimate water fluxes from voltage differences observed in the sea. Preliminary results show that significant motionally fields are generated both in the magnetic and electric fields. For instance, the motionally induced magnetic field in the vicinity of Kakioka Magnetic Observatory amounts up to a few nT. This could affect estimates of the core field at the observatory. Comparison with large-scale voltage differences in the region will be presented.

Keywords: induction, modelling, seawater

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

JAS004 **Oral Presentation** **372**

Development of Microsoft.NET (C#) program and finite difference electro magnetic modeling of Krishna-Godavari Basin

Dr. Prabhakar Rao
IUGG US007

Dr. K Mallick, Mr. G. Ashok Babu

A Microsoft.NET Graphic interface program is developed to compute the apparent resistivities of two-dimensional geological structures for magneto telluric (MT) H-polarization case, using finite difference technique. The program is useful to view different models in the Microsoft.NET Framework and interpret the geophysical data. Different Microsoft.NET tools have been used to develop the program. C# classes, with member functions are designed and object oriented programming features such as inheritance, encapsulation are utilized in developing the program. Database tools have been used in this program. Microsoft Access database is used to input the required data. The program is used to study the response of different layers of the Krishna Godavari basin. Krishna-Godavari (K-G) Basin in the east coastal region of Andhrapradesh, India with an estimated inland area of 15,000 sq.km and a vast offshore exposure, is a major source of hydrocarbon. Oil and Natural Gas Commission (ONGC) has carried out extensive geological and geophysical investigations, and delineated several structures. On the basis of the investigations done by ONGC, drilling has been carried out and both oil and gas have struck. There have been significant discoveries of oil and gas during the past three years and particularly during the end of year 2006. 2D finite difference MT modeling has been carried out, with the present program which we have developed using Microsoft.NET technology, along four profiles over which seismic data has been collected and interpreted, to examine the response pattern, resolution of different subsurface layers and the effect of the top basalt layer. Our results reveal that: (i) Unlike in reflection seismics where high velocity basaltic overburden absorbs energy, the resistive basaltic cover favours deeper penetration of electromagnetic energy. (ii) Broad- band MT measurements in the range of 10-4 Hz to 10Hz provide better resolving capabilities for mapping electrical discontinuities at different depths. (iii) The bed rock consisting of ridges , horst, granitic rocks and thick sediments deposited on the basement depressions are distinctly observed in magnetic, resistivity contour and image maps. Based on the investigations carried out on different sections of K-G basin, we have come to a conclusion that the overlying volcanic rocks and the basement granitic rocks offered in ideal situation to resolve the conducting sedimentary sequence. The Microsoft NET program which we have developed, and the modeling which has been carried out on K-G basin, may be very much helpful to the geophysical community to resolve the different layers of the earth section, particularly in sedimentary formations. The present study can also be extended to other sedimentary basins where the seismic reflections are poor either due to the presence of overlying high velocity layers or undulating structures, such as folds and ridges.

Keywords: c sharp classes, finite difference technique, object oriented prigramming

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

JAS004 **Oral Presentation** **373**

Geomagnetic jerk time delays

Mrs. Katia Pinheiro
Geophysics ETH IAGA

Andrew Jackson

Geomagnetic jerks are abrupt temporal variations of the magnetic field believed to be due to motions in the fluid core. The most well known jerks, in 1969 and 1978, are worldwide and show an intriguing temporal-spatial pattern: a first arrival in the Northern hemisphere followed by a delayed arrival in the Southern hemisphere of about 3years. There are two possible hypotheses to explain this temporal pattern: the first is to consider these differential time delays as being generated by dynamical processes in the core which do not occur simultaneously; the second is to consider jerks generated instantaneously in the core and the time delays as being caused by aconducting mantle. In this paper we analyze the second hypothesis so that the geomagnetic field observed at the surface will correspond to a filtered version of the original field generated in the core. We developed the forward approach to this problem using a radial mantle conductivity model acting as linear, causal and time-invariant filter.The jerk is simulated as an impulse in time at the CMB and its morphology in the core obtained by a global spherical harmonic model. The key point is that the mantle filter is different for each harmonic degree. Therefore, as the mixing of harmonics varies with location at the CMB, distinct time delays will exist in different locations at the Earth's surface.

Keywords: jerks, mantle, conductivity

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

JAS004 **Oral Presentation** **374**

Electromagnetic depth sounding on a multi-layered transitional earth using rectangular loop source

Dr. Prabhakar Rao
IUGG US007

Mr. Ashok Babu Ganjam

The interpretation of EM measurements requires the assumption of a suitable earth model. For many exploration problems it is assumed that the layers of the earth have homogeneous resistivities and sharp boundaries. However, in many instances it has been observed that resistivity in certain layers of the earth is not homogeneous and does not abruptly change, rather it varies continuously with depth. For example, the presence of weathered rocks in igneous terrain, the interface between fresh and sea water in coastal region, clay deposits containing varying amount of sand in sedimentary formations, fissured limestones etc., do exhibit general change in electrical conductivity. The regions of varying conductivity represent transitional earth. In the present paper, an integral expression is derived for the vertical magnetic field produced by large horizontal rectangular loop placed over a transitional multilayered earth. The integral expression is derived using the concept of reciprocity and the known solution for the electric field of a vertical oscillating magnetic dipole source on a multi-layered transitional earth. A C++ program is also developed to compute the normalized vertical magnetic field of a horizontal rectangular loop placed on the surface of n-layered transitional earth. The field can be calculated either inside or outside the loop. C++ classes with member functions are designed to compute the kernel function, Hankel transform integral and the normalized vertical magnetic field. The digital fitter technique is used to evaluate the Hankel integral. The program utilizes many object oriented programming features, particularly encapsulation and inheritance. The program computes the amplitude and phase of the normalized vertical magnetic field for both geometric and parametric soundings. The effects of the variation of transitional layer thickness for the earth models with resistive and conductive basements are studied. The plots for amplitude and phase are drawn in parametric and geometric soundings. The plots may be useful to select suitable frequency and transmitter receiver distance ranges to design field experiments for effective sounding results.The mathematical solutions and the C++ program are useful to geoscientists for computing the model data to fit and interpret field observations on transitional multilayered earth.

Keywords: transitional earth, c plus plus classes, em depth sounding

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

JAS004 **Oral Presentation** **375**

Joint MT and CSEM inversion in active geothermal area at volcano Mutnovsky, Kamchatka peninsula

Dr. Oleg Pankratov
Department of main geomagnetic field IZMIRAN IAGA

Andrey G. Yakovlev, Elena V. Andreeva

The idea of better use of electromagnetic data owing to collective data analysis lies in the scope of inversion techniques. This idea has been implemented, deployed, and applied to magnetotelluric data as well as controlled source electromagnetic data [1]. Namely, we developed quasi-one-dimensional inversion algorithms that exploit collective inversion with non-quadratic stabilization algorithm so that they bring much more resolution ability to the interpretation than conventional techniques. In this work we describe the method and show how it was applied to geothermal studies in the area of volcano Mutnovsky, Kamchatka peninsula, Russie. Three years (2004, 2005, and 2006) there was a series of surveys performed in the active geothermal area of volcano Mutnovsky [2] where hydrothermal power plant Mutnovskaya is located. These surveys comprised of magnetotelluric/audiomagnetotelluric (MT/AMT), and controlled source electromagnetic (CSEM) data acquisition. MT/AMT data pertain to frequency range 100 Hz to 1000 s. CSEM data pertain to frequency range 1500 Hz to 6 s. A 5350 m long source electric dipole was located 7 km far from the observation area. It was fed by electric current from generator T-30 produced by Phoenix Geophysics Limited. Total data volume was more than 1000 observation sites. The data obtained from these surveys were used in joint inversion to obtain geoelectrical model of the region. The reason to combine MT/AMT and CSEM data was that these two kinds of data have different nature, sensitivity and signal/noise ratio. First, all the data were corrected for random static shift. Second, the data were analyzed, and some data sites were rejected due to their too much noisy character. Third, our quasi-one-dimensional inversion has been applied to MT/AMT data and produced a zero-version of cross-section of resistivity rho(x,y,z). Fourth, this zero-version cross-section was validated against geological, geothermal, and hydrothermal a priori data in the region. Fifth, the zero-version cross-section was used to perform a series of three-dimensional modelings and to correct CSEM data for local three-dimensional inhomogeneities. Sixth, total data volume (MT/AMT/CSEM) was used to find the model with the use of our quasi-one-dimensional inversion for MT/AMT/CSEM data. Finally, an anomalous conductive conductive zone has been obtained supposed to represent hydrothermal reservoir that is important to Mutnovskaya power plant. References [1] O. V. Pankratov, A. G. Yakovlev, E. V. Andreeva, Quasi-One-Dimensional inversion: a non-quadratic algorithm in geoelectromagnetic research. Proceedings of the conference Tikhonov and contemporary mathematics. Session Mathematical geophysics, p. 52-53, Moscow, 2006. [2] A. G. Nurmukhamedov, I. I. Chernev, A. G. Yakovlev, O. V. Pankratov, R. G. Batyrshin, D. A. Alexeev. The newest geophysical exploration results at Mutnovskoe hydrothermal deposit on Kamchatka peninsula. Proceedings of the conference Saint-Petersburg 2006, EAGE-EAGO-SEG-Lenexpo, Saint Petersburg, 2006.

Keywords: csem, mt, inversion

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

JAS004 **Oral Presentation** **376**

Marine Controlled Source Electromagnetics Using a Bottom Towed System to Explore Submarine Cold Vent Sites in Cascadia and New Zealand

Dr. Katrin Schwalenberg
IAGA

Marine controlled source electromagnetics has become one of the most promising methods for offshore hydrocarbon reservoir evaluation in recent years and thus is more and more frequently used as a complement to seismic methods by the offshore oil industry. Here we report on data we collected with a bottom towed electric dipole-dipole system over several gas vent fields which are associated with sub-seafloor gas hydrate deposits along the coast lines off Western Canada and New Zealand. We target at the upper 100-200m below seafloor in water depth between 700-1300m and demonstrate through 1D inversion and 3D modeling that the electrical response of the vent sitesare clearly depict by our data.

Keywords: marine csem, gas hydrate

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

JAS004 **Oral Presentation** **377**

Bayesian stochastic sampling for inversion of magnetotelluric and geomagnetic induction data

Dr. Josef Pek
Dept. of Geoelectricity Geophysical Institute, Acad. Sci. Czech Rep. IAGA

Vaclav Cerv, Michel Menvielle, Fernando A. M. Santos

Bayesian sampling approaches, based on assimilating the prior model information and the experimental data available, aim at providing estimates of both the model parameters and their uncertainties by generating model samples distributed according to the true posterior probability of the model parameters conditioned on the data. Though still computationally very demanding in most of the cases, the Bayesian sampling by the Monte Carlo method with Markov chains (MCMC) has recently become feasible for several model classes commonly used in interpreting data of practical electromagnetic depth soundings. We present results of the application of the Bayesian Monte Carlo stochastic sampling approach to the solution of non-linear inverse problems of the electromagnetic induction in the Earth for three particular model settings the anisotropic layered Earth, 2-D conductivity distribution in the Earth, and quasi-3-D conducting structures approximated by a laterally non-uniform thin sheet. We compare two MCMC sampling procedures for all the three model settings, the standard Gibbs sampler and a new Single Component Adaptive Metropolis algorithm. The latter algorithm shows particularly promising in 2-D and quasi-3-D model settings, as it effectively reduces the number of costly direct solutions in a single MCMC iteration step. Further computation savings can be achieved by employing the Sherman-Morisson formula in updating 2-D direct solutions for weak conductivity changes that affect only a small number of cells in the model, or by updating the direct solution via linearization if parametric sensitivities are available. We demonstrate the performance of the stochastic algorithms on synthetic models, as well as on experimental magnetotelluric and geomagnetic induction data from SW Portugal and NW Poland.

Keywords: inverse problem, stochastic sampling, magnetotelluric

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

JAS004 **Poster presentation** **378**

ESTIMATION OF CORRELATION MATRIX

Mrs. Karine Karapetian
IAGA, JASPEI JSS, JSA IASPEI

Zaven Chilingarian

In prospecting geophysics at interpretation of the observation data linear filters are frequently applied. Construction of any transformation of a geophysical field, i.e. any filter, will be carried out within the framework of the certain mathematical model. Relative character of concepts of a useful signal and a hindrance can be presented mathematical model: fj = Srj + Slj + nj, where the observed field fj is represented by the sum regional (Srj) and local (Slj) anomalies and noncorrelative hindrance (nj). The given problem is solved in frameworks of regressional and componental analyses where observed fields model is described by system of random variables. We use the energetical filter which is constructed as the filter of detection and allocation of anomalies. If a hindrance noncorrelative - the correlation matrix is symmetric. After transposing eigen values of this matrix of geophysical observation data on decrease: ? > ? >... > n, the eigen vectors appropriate to them (weight functions) are calculated. By the filtration of reference values fj we receive orthogonal transformation Yjk = hikfj-i, where k is an index of eigen value. From a plenty of results of geophysical observation on Mekhradzor deposit of Armenia on eleven profiles, the data of methods of natural electric field (NEF), electric resistance and magnetoprospecting are chosen. The essence of our research - to state a quantitative estimation of contributions of eigen values in the general dispersion for each method, to reveal and estimate opportunities of interpretation of reference values for electroprospecting methods. As a result of researches it was found out, that at a magnetoprospecting method the sum of first two eigen values gives more than 98 % of contributions to the general dispersion. At a method of electric resistance the sum of contributions more than 96 % are reached by three eigen values, and at NEF method the same turns out only after six eigen values. In the conclusion it is possible to infer, that estimating of correlation matrix of a geophysical field- all number of eigen values and the eigen vectors appropriate to them, i.e. weight functions, it is possible to solve with greater reliability a task of allocation of a useful signal in the general mix of rather difficult electric fields.

Keywords: statistics

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

JAS004 **Poster presentation** **379**

Geoelectric cross-section of the Northern Urals lithosphere

Prof. Peter Martyshko
Math Geophysics Institute for Geophysics, Ural Branch of RAS IAGA

Aza Dyakonova, Olesya Surina

There are presented the results of complex electromagnetic sounding with artificial field source (160 kHz 700 Hz) and magneto telluric ones (2000 Hz 4 ·10-4Hz) in this work. The investigations are oriented on the solving of a fundamental problem: what is the connection between lithosphere structural - tectonic formation of folded belts on the Urals and particularities of crust conductivity distribution in the upper mantle. In 2005 complex geological and electromagnetic researches were continued in the Northern Urals along profile of 500 km length (with the latitude of 59 20'). A complete geoelectric cross-section in the range depths from 10 m to 120 km has been constructed. An important information was obtained on the lithosphere stratification on electrical parameters at different deep levels. There are subvertical inserts or inclined conducting inserts (from 10 to 20 km depths) being marked by zones of tectonic dislocations. From our opinion, there is a connection with an extended crust conductor having a fluid nature. A principal result is obtained for depths from 60 to 120 km. There are distinguished two types of geoelectric sections with and without of a higher conductivity layer in central zones of the Northern Urals (Central Urals uplift, Tagil megazone and Eastern Urals uplift). A substantial difference conductivity values at big depths in a stripe of 230 km is well correlated with a thermal flow distribution in a given cross-section and with a great share of probability can have particularities of the Urals in Paleozoic. There are

Keywords: electromagnetic, sounding, conductivity

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

JAS004 **Poster presentation** **380**

Imaging the subsurface in the Cameroon Centre Province using the Audiomagnetotelluric (AMT) soundings for the monitoring of the Monatele-Saa earthquake area.

Dr. Ndougsa-Mbarga Theophile
Physics Advanced Teacher's Training College, University o IAGA

Gouet Daniel Henry, Manguelle-Dicoum Eliezer

In monitoring the Monatel-Saa earthquake area, audiomagnetotellurics investigation were done using a scalar instrument with a frequency range from 4.1 Hz to 2300 Hz. Data have been collected along a profile directed N-S, having seven stations and running aproximatively 20 km.This profile is crossing the Sanaga river which seems to be parallel to a big fault burried in the subsurface without any indications on the topsurface. The application of a statistical approach for the processing of the resistivity data collected on the field and their interpretation using 1D and 2D modelling have permitted to put in evidence from the image of the subsurface two major discontinuities. These discontinuities are: The Sanaga fault oriented SSW-NNE and covered by a thick layer of alluvial deposits and sand; The Biakoa-Goura II fractures zone characterized by a fault oriented N-S. This fault is correlated to the Pan African tectonic movement. Its also covered by a thick lateritic layer going up to 55 km in the subsurface. The Biakoa-Goura and Sanaga faults tectonic node relaxation seems to be the origin of the February 2005 earthquake in Monatel and Yaounde North areas.

Keywords: audiomagnetotelluricsounding, 1dand2dmodellig, faultandtectonicnode

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

JAS004 **Poster presentation** **381**

Two-and-half-dimensional inversion modeling for CSEM data

Dr. Qingyun Di
Insititute of Geology and Geophysics Insititute of Geology and Geophysics, CAS

Changmin Fu

We present two-and-half-dimensional (2.5D) inversion modeling for the interpretation of Marine controlled-source electromagnetic (CSEM) data. The paper introduces the Rapid Relaxation Inversion method of CSEM data. This method is a kind of approximate inversion method, it bases on 2.5D finite element forward modeling and CSEM-RRI approximate solution of sensitivities matrix and pseudo 1D inversion of models parameters. The paper first shows the inversion results for 100Ωm half space earth media in different transmitter and receiver offset. And then we did the inversion for two dipping conductivity anomalies model. The inverted results show the anomalies can be inverted to correct position for dipping conductivity bodies, but the anomaly area is larger than original model, especially the dipping anomaly extends to deeper media. Even so, almost all the misfits (RMS values) are less than 2, the inversion resolution is quite high. In order to compare the 2.5D inversion results from Abubakar (2006), we used the same model as Abubakar. The model consists of an 8km wide, 100m thick reservoir located at 1 km depth in a half-space medium. The conductivity for sea water is 3S/m, the sea water depth is 1km. the reservoir conductivity is 0.05S/m, and the depth is about 2km. A grid of 100 cells in x-direction (strike direction of the reservoir) and 50 in z direction was employed within the 2.5D modeling. To simulate the noise in real data, random Gauss noise was added to the synthetic data before inversion. The imaging results from the Ex-Hy data with our 2.5D algorithm show that the reservoir is resolved very well, and it has excellent agreement with the Abubakar results.

Keywords: csem, two and half dimensional, inversion

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

JAS004 **Poster presentation** **382**

Global optimization for the interpretation of magnetotelluric sounding data using polynomial approximation and estimation of static shift

Dr. Shashi Prakash Sharma
Department of Geology and Geophysics IIT, Kharagpur, WB , 721302-INDIA

Marta Kis

Near surface conducting bodies can severely distort magnetotelluric (MT) apparent resistivity data. This distortion is due to an electric field generated from boundary charges on surficial inhomogenities, and persists throughout the entire MT recording range and is known as static shift (e.g., S) in Magnetotellurics. Frequency independent static shifts are manifested as a vertical, parallel shift that occurs in the dual logarithmic scale of apparent resistivity vs. time period plot. The phase of MT data remains unaffected by the static shift and can be used to remove the static shift. However, inversion of phase data alone will not work, as it will not lead to a unique solution. Inversions of the static shift corrected MT data provide better estimates of resistivities and thicknesses than the inversion of uncorrected data. Hence, static shift must be removed from the data before inverting it to get the reliable earth model. In the present study boundaries between various layers in subsurface are expressed in terms of polynomial. The coefficients of polynomial representing the boundary are optimized using very fast simulated annealing (VFSA) approach. Further, static shift is considered as one of the model parameter (different for each station along a profile) and optimized together with other model parameters using VFSA global inversion technique. As a result, model parameters as well as estimates of the static shift present in the data are determined simultaneously for a number of stations along a profile. Synthetic and noisy data generated for a number of models are used to show the efficacy of the approach in getting reliable estimate of the subsurface when the apparent resistivity data is affected by static shift. Study shows that the joint inversion of the apparent resistivity and phase data inverted together without or with considering static shift for optimization yields good fit between the observed and model data. Joint inversion results show that estimated resistivities are S times of the true resistivities and estimated thicknesses are squareroot(S) times of the true thicknesses without optimization of static shift. Further, joint inversion of the apparent resistivity and phase data inverted together and also optimized for the static shift yields the best estimate of the subsurface structures.

Keywords: static shift, global inversion, magnetotellurics

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

JAS004 **Poster presentation** **383**

The non-harmonic downward continuation method in deep earth magnetic field studies

Dr. Ludwig Ballani
Geodesy and Remote Sensing GeoForschungsZentrum Potsdam (GFZ) IAG

Dietrich Stromeyer, Hans Greiner-Mai, Jan Hagedoorn

There are more and more high-quality global geomagnetic data sets available with dense temporal and spatial resolution or covering long time spans. In addition to the progress of outer space field research and crustal studies these data sets allow for more precise modelling in the deep earth interior if they are coupled with quantities related to dynamics and geodynamo calculations. Thus, it is desirable to know the temporally magnetic field in the zone around the core-mantle boundary (CMB) with high resolution in space and time. For this, an appropriate approach, the non-harmonic downward continuation method, has been implemented which is based on the solution of an inverse ill-posed initial-boundary-value problem. It calculates the field at a lower boundary in the deep earth interior with data (Gauss coefficients) given at the earth surface and assuming any radially dependent mantle conductivity model. Here with some examples, we demonstrate the possibilities of this method and show its sensitivities. We compare the resulting fields with those basing on a non-conducting mantle. The main differences are found in the amplitudes and phase shifts of temporally varying processes. This is shown in detail for all three magnetic field components at the CMB by means of simulated oscillations. In addition, the dependence on the assumed conductivity or conductance is analysed, especially the influence of conductivity jumps possibly existing in the vicinity above the CMB. Clear phase shifts can be observed if rapidly proceeding temporal trend changes (with its high frequency character)are mapped from the earth surface onto the CMB region where this phenomenon can be seen at an earlier stage and closer to the causing processes

Keywords: geomagnetic field, core mantle boundary, mantle conductivity

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

JAS004 **Poster presentation** **384**

Advanced methods for regional magnetotelluric profile studies of active orogens: the experience from the Central Tian Shan

Dr. Elena Sokolova
Geoelectromagnetic Research Center Institute of the Physics of the Earth IAGA

M. Berdichevsky, Iv. Varentsov, N. Golubtsova, A. Rybin, N, Baglaenko, V. Batalev, P. Pushkarev, I. Safronov

The areas of active orogenesis are attractive objects for multi-disciplinary geological-geophysical studies, possessing the fundamental geodynamic knowledge. The complex structure of these objects introduces rigorous requirements to the modern methods of their investigation, including high precision of data acquisition and processing, effective analysis of the processing results, defining the dimensionality of the interpretational model, and finally, high resolution and stable inversion tools. We present the experience of the Central Tian Shan resistivity section studies along the regional transect of magnetotelluric (MT) soundings Naryn crossing the orogen from the North to the South. A complex of new methods was elaborated and applied to increase further the resolution and stability of the reconstruction of this multi-level heterogeneous geoelectric media, still being formed since Cenozoic activization till nowadays. The basic method of data acquisition, synchronous soundings, has brought the extended data set, combining on the heterogeneous grid of 700-km-long profile tens of broad-band and long-period MT sites. The data were processed with the new tools, using simultaneous observations for suppressing noises and stabilization of long-period responses and supplying the estimates of local and inter-station transfer functions (TFs). Due to the application of invariant analysis schemes robust to galvanic distortions and high precision estimates of all the components of TFs (including additional ones) reliable strike and dimensionality parameters were obtained and two-dimensional approach for further interpretation was approved. Quasi 2D ensembles of transfer functions for profile inversion in broad-band and long-period ranges were compiled from the impedances, tippers and horizontal magnetic tensors estimates. Each component of the data sets was rotated according to the regional sub-latitude tectonic strike and supplied with a specific mask of weights, reflecting estimation accuracy and a quantitative measure of local 3D distortions. The results of successive partial and multi-component bi-modal inversions are presented. They were obtained with the regularized 2D inversion code, using adaptive block and piece-wise continuous approximation of conductivity distributions with accounting for topography and a variety of resources for the solution stabilization [Varentsov, 2007, this symposium]. The strategy was aimed to the suppression of the 3D distortions and focusing on the target 2D geoelectric features. It implied model sensitivity studies, reasonable choice of a staring model, the priority of phase and geomagnetic data and using of specially designed quasi 2D data ensembles . The application of the powerful well-focused inversion tools and representative character of data sets have permitted to obtain more resolution of the conductivity distribution along Naryn profile in comparison with the earlier studies. The important features of geoelectric structure resolved are the low crustal conductive layer, sporadically revealed upper crustal one and the sub-vertical large-scale conductive zone in upper and middle crust under Nikolaev Line tectonic unit, which find the explanation in the terms of Tian Shan orogen geodynamics. This study was supported by grant RFBR 04-05-64970.

Keywords: magnetotelluric, inversion, tian shan

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

JAS004 **Poster presentation** **385**

Long Period Magnetotelluric (MT) study using Geomagnetically Induced Currents in the Scottish Power network

Dr. Allan McKay
Seismology and Geomganetism Programme British Geological Survey IAGA

Antti Pulkkinen, Alan Thomson

Geomagnetically Induced Currents (GIC), which flow in technological systems such as power transmission grids, are a consequence of the geoelectric field induced at the surface of the Earth during geomagnetic storms. We use an electrical model of the power network, measured GIC data and geomagnetic data from Eskdalemuir observatory to estimate the MT impedance. The derived MT responses are generally smooth and stable over a period range consistent with the length of the time series used in their computation. For example, at one site we use 10 days of one-second data: smooth and stable responses are generated over the period range 5-5000s. We compare our derived MT responses to previous conventional MT studies in the northern England and southern Scotland region.

Keywords: magnetotellurics

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

JAS004 **Poster presentation** **386**

Numerical simulations of the new deep electromagnetic sounding of the mantle

Dr. Jan Vozar
Department of Geomagnetism Geophysical Institute, Slovak Academy of Sciences IAGA

Vladimir Yu. Semenov

Forward modeling of the electromagnetic fields induced on the spherically layered Earth with inhomogeneities at the mantle has been carried out to simulate the responses obtained by the new approach to the horizontal spatial gradient (HSG) method in comparison with other sounding methods. For some models, the globe has been covered by the shell of surface inhomogeneities by incorporating the recent European data. The HSG method has been evaluated in accordance with the conventional (old) and new (including the spatial derivatives of impedances) approaches to compare their efficiency for the study of heterogeneous media. The modeled apparent resistivities and the impedance phases are presented for the period ranging from tenths of a day to many days, at which both the magnetotelluric and magnetovariation methods could be realized in practice. Possibilities of the deep magnetotelluric and magnetovariation soundings are compared using examples from the European region.

Keywords: magnetovariational soundings, theretical modeling

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

JAS004 **Poster presentation** **387**

Electromagnetic study at the Antarctic station Vernadsky Region

Prof. Valentyn Maksymchuk
Dynamics of the Geomagnetic Field Carpathian Branch of the Institute of Geophysics

Borys Ladanivskyy, Igor Logvinov, Victor Tarasov

The data acquired recently by new electromagnetic instrumentation at Ukrainian Antarctic Station Vernadsky, former Faraday,(geomagnetic observatory Argentinian Islands, AIA) and surrounding region were used for estimation of electromagnetic transfer function. The magnetotelluric (MT) impedance tensor for one site AIA (Galindes island) and magnetovariational transfer function for three sites (Galindes, Pitterman and Barthelot islands) were obtained for period band 36 10000 sec. The frequency dependences of magnetovariational transfer function represented as real Cu and imaginary Cv induction arrows for all sites have a similar behaviour. Maximums of Cu are quite close to 0.4 and corresponds to period band 3000 4000 sec. Azimuths of Cu in this band equal to 160-170 dgr. Cv values tends to be more scattered. But the obtained frequency dependence of Cu and Cv differ extremly from the results for shoreline geomagnetic observatory such as Mirnyy (MIR) and Dumont D'Urville. The analysis of the MT data have showed the main directions of the impedance tensor. The azimuth 50 dgr corresponds to the maximum impedance and coincides with the continental shore line direction in this region. Correspondingly the orthogonal azimuth equal to 140 dgr, where minimum of impedance is revealed is orthogonal to continental shore line. The one dimensional inversion of magnetotelluric data do not detect any well conducting objects in the geoelectrical cross-section of region up to bottoms crust and upper mantle. Only one conductive object was revealed at depth less then 400 m with conductivity 2700 S and can be explained by conductivity of sea water. Using obtained results and available geological information direct two dimensional electromagnetic simulation along the profile from Belinthgauzen Sea crossing the Antarctic peninsula to Wedell Sea was done for prediction of suitable measuring sites which can help to reveal of geoelectrical heterogeneity in structure of crust and upper mantle in future.

Keywords: magnetotelluric, magnetovariation, antarctic

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

JAS004 **Poster presentation** **388**

Electrical conductance modelling for central Italy

Dr. Domenico Di Mauro
Geomagnetism Dept. INGV - Roma2, ROME - ITALY IAGA

Angelo De Santis, Vaclav Cerv, Michael Menvielle, Josef Pek, Svetlana Kovacikova

Long period geomagnetic transfer functions across Central Italy were used to determine the spatial distribution of the electrical conductance. Transfer functions for periods of 1000 to 7000 s are available at several sites from a geomagnetic depth sounding network set up in the late 1990s in this area.Preliminary direct thin sheet models from estimated conductance of seas and surface and sea bottom sediments do not explain the observed data satisfactorily. By means of the Monte Carlo Markov chain approach (MCMC) we obtained an improved model which better solves the inverse problem for the electrical conductance distribution across the region with a good fit to the experimental data.Correlation of the results to the local geology is discussed.

Keywords: geomagnetic, transfer, functions

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

JAS005 **389 - 402**

Symposium
The role of aerosols and dust in the middle atmosphere

Convener : Prof. Franz-Josef Luebken, Dr. Richard Goldberg

The middle atmosphere (MLT) is now thought to contain large quantities of charged dust and aerosols which can be responsible for many unusual phenomena such as noctilucent clouds (NLC) and polar mesospheric summer echoes (PMSE). Recently, there has been a flurry of new measurements and studies concerning this dusty plasma in the MLT. This session will concentrate on its origin, including the shape, size, and composition of the particles composing it. Both recent measurements and theoretical considerations will be highlighted. These considerations will also include such items as event dependence on background conditions, the frequency and global distribution of the induced phenomena, southern hemisphere/northern hemisphere differences, and long-term changes

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

JAS005 **Oral Presentation** **389**

Novel model of atmospheric electric field.

Prof. Vladimir Kuznetsov
Far Eastern Branch of Russian Academy of Sciences Institute of Space Physical Researches IASPEI

Novel model of atmospheric electric field (AEF) based on the idea of AEF generation due to electric charges separation in fair weather atmosphere is proposed. If thunderstorms are absent then the electric charges in the atmosphere are formed through its ionization by galactic cosmic rays (GCR). Light positive ions are lifted by upward currents to the upper layers of atmosphere and heavy negative aerosols fall to the Earth. The model provides the explanation for Carnegie curve of atmospheric electric field and for some other features of atmospheric electricity; in particular, AEF behavior and Forbush decreases of GCR during geomagnetic disturbances. The problem of AEF secular decrease against the Earth surface temperature, the results of experiments on AEF excitation, AEF behavior during earthquakes and seismovibrators run are discussed.

Keywords: atmospheric electric field, charges separated by aerosols

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

JAS005 **Oral Presentation** **390**

Global observations of water vapor and ice content in the Mesosphere together with co-located measurements of temperature and ozone

Dr. Edward Llewellyn
Institute of Space and Atmospheric Studies University of Saskatchewan

Richard L. Gattinger, Michael H. Stevens, Jorg Gumbel

The OSIRIS instrument on the Odin satellite provides observations of both the airglow and the scattered sunlight limb spectra, over the wavelength range 280 810 nm, as well as limb images of the oxygen infrared atmospheric band and the OH Meinel 3-1 band airglow. Although the recorded spectra only have a 1 nm resolution it is possible, following the MAHRSI high resolution observations, to identify the OH (A-X) resonance emission in the measured spectra. These measurements can be combined with models to determine the mesospheric water vapor profile, the ice content is identified from the PMC signature in the measurements. The OH (A-X) emission is also excited in the Lyman-alpha photolysis of water, although in this case the prompt emission occurs in hot lines and so provides a direct measure of the water vapor content. The spectrograph observations of the oxygen atmospheric A-, B- and gamma-bands and the imager observations of the oxygen infrared atmospheric band provide common volume information on temperature and ozone concentration. In this paper some of the new OSIRIS global observations will be presented and the need for clarifying independent information identified.

Keywords: water vapor, ozone, temperature

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

JAS005 **Oral Presentation** **391**

Research results on atmospheric electric field at observatory Paratunka in Kamchatka.

Prof. Vladimir Kuznetsov
Far Eastern Branch of Russian Academy of Sciences Institute of Space Physical Researches
IASPEI

Cherneva N.V., Druzhin G.I., Babahanov I.Y.

Decennial (from 1997 to 2006) research data on measurements of atmospheric electric field (AEF) intensity in the surface layer are discussed. The data are analyzed in two variants: in undisturbed environment of broad anticyclone (fair weather conditions FWC) and in oncoming cyclone environment. During research time and under FWC we revealed the apparent evening-morning asymmetry of daily shape of Ez, whose magnitude and features are season dependent. Noted during equinox the maximum asymmetry is accounted for Sun unitary variation and Sun rise superposition caused by observatory location. The magnitude of AEF decreases with pressure decreasing as the cyclone approaches. The AEF decrease is assumed to arise from the high negative charge the cyclone carries and approaching the point of observation the cyclone induce the electric field reversed in sign here. One and half thousand kilometers is the distance the electric field is revealed to start its response to the cyclone. Results of active experiments on AEF exposure to the vapor jet out of the hydrothermal well are given. Decrease of average annual Ez follows from decennial observations of AEF at Paratunka observatory.

Keywords: atmospheric electric field, observations in kamchatka

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

JAS005 **Oral Presentation** **392**

The Aeronomy of Ice in the Mesosphere Mission

Prof. James Russell
Atmospheric and Planetary Sciences Hampton University IAGA

Scott M. Bailey

The overall goal of the Aeronomy of Ice in the Mesosphere (AIM) mission is to resolve why Polar Mesospheric Clouds (PMCs) form and why they vary. By measuring PMCs and the thermal, chemical and dynamical environment in which they form, AIM will quantify the connection between these clouds and the meteorology of the polar mesosphere. This will provide the basis for the study of long term variability in the mesospheric climate and its relationship to global change. The results of AIM will be a rigorous validation of predictive models that can reliably use past PMC changes and present trends as indicators of global change. This goal will be achieved by measuring PMC abundances, spatial distribution, particle size distributions, gravity wave activity, cosmic dust influx to the atmosphere and precise, vertical profile measurements of temperature, H2O, OH, CH4, O3, CO2, NO, and aerosols. The AIM satellite carries three instruments including the Solar Occultation for Ice Experiment (SOFIE), the Cloud Imaging and Particle Size Experiment (CIPS) and the Cosmic Dust Experiment (CDE). Launch is scheduled for late April, 2007. This talk will summarize the science goals, measurement requirements, the expected performance of the AIM instruments and any early results available at the time of the symposium.

Keywords: mesosphere, clouds, satellite

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

JAS005 **Oral Presentation** **393**

Lidar sounding of Noctilucent Clouds

Dr. Gerd Baumgarten
Optical Sounding and Sounding Rockets Leibniz-Institut fr Atmosphrenphysik IAGA

Noctilucent clouds (NLC) are ice clouds that form at high latitudes and altitudes of 82km, and are potentially a sensitive tracer for global change at the mesopause region. To understand the observed variations of NLC on scales from minutes to several years a comprehensive understanding of the nature of the tracer is needed. Active remote sensing of noctilucent clouds by lidar allows to observe the clouds with a high temporal and spatial resolution. In addition the optical properties of the clouds can be observed quantitatively and precisely to deduce particle properties, e.g. the mean size of the ensemble of particles forming the clouds. While the application of the lidar technique to NLC was proposed already in 1886 only 100 years later lidars for observing NLC have come into routine operation. NLC are faint clouds having optical depths of roughly 10E-5, resulting into rather complex experimental setups for their observation especially under daylight conditions. We will give an overview of the observations and review the capabilities of lidar systems with focus on the advantages of the systems to perform repeatable and precise observations 24 hours a day.

Keywords: nlc, lidar, clouds

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

JAS005 **Oral Presentation** **394**

What can we learn from interhemispheric differences of mesospheric ice layers ?

Prof. Franz-Josef Luebken
IAGA

Uwe Berger

Ice layers in the summer mesosphere at middle and polar latitudes are very sensitive to background conditions, such as temperatures, water vapor, and transport. These layers appear as'noctilucent clouds' (NLC) and 'polar mesosphere clouds' (PMC) when observed by optical methods from the ground or from satellites, respectively. They also lead to very strong radar echoesknown as 'polar mesosphere summer echoes'(PMSE) which allows permanent observations even during bad weather conditions. A newly developed model of the atmosphere called LIMA (Leibniz Institute Middle Atmosphere Model) nicely reproduces the mean conditions of the summermesopause region and is used to study the ice layer morphology. The background variability has a major impact on the geographical distribution of ice clouds. Since ice layer formationis very sensitive to the thermal structure of the mesopause region the morphology of NLC/PMC/PMSE is frequently used to study, for example, inter-hemispheric differences of upper mesosphere temperatures.Some ice cloud observations suggest a difference between the northern (NH) and southern hemisphere (SH) summer. However, details of this potential difference and the physical and photo-chemical processes involved are not understood. With LIMA we have studied in detail the inter-annual variabilityof upper mesosphere temperatures and ice clouds in the NH and SH, as well as potential interhemispheric differences. It turns out that the NH/SH temperature difference increases with decreasing latitude which, for example, explains the non-existence of PMSE at 62S, whereas they are frequently observed at similar NH colatitudes.

Keywords: mesophere, ice layers, interhemispheric comparison

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

JAS005 **Oral Presentation** **395**

Modeling the temporal and geographical variability of the micrometeor mass input in the upper atmosphere using radar measurements

Dr. Diego Janches
CoRA Division NorthWest Reasearch Associates IAGA

Jonathan T. Fentzke

It is now widely accepted that microgram extraterrestrial particles from the sporadic background are the major contributors of metals in the Mesosphere/Lower Thermosphere (MLT). It is also well established that this material gives rise to the upper atmospheric metallic and ion layers observed by radars and lidars. In addition, micrometeoroids are believed to be an important source for condensation nuclei (CN), the existence of which is a prerequisite for the formation of NLC particles in the polar mesopause region. In order to understand how this flux gives rise to these atmospheric phenomena, accurate knowledge of the global meteoric input function (MIF) is critical. This function accounts for the annual and diurnal variations of meteor rates, global distribution, directionality, and velocity and mass distributions. Estimates of most of these parameters are still under investigation. In this talk, we present results of a detailed model of the diurnal, seasonal and geographical variability of the micrometeoric activity in the upper atmosphere. The principal goal of this effort is to construct a new and more precise sporadic MIF needed for the subsequent modeling of the atmospheric chemistry of meteoric material and the origin and formation of metal layers in the MLT. The model is constructed based on meteor radar observations obtained with the 430 MHz dual-beam Arecibo (AO) radar in Puerto Rico, the 50 MHz Jicamarca (JRO) radar in Peru and the 1.29 GHz Sondrestrom radar in Greenland, thus utilizing almost the entire NSF ISR chain. The model uses Monte Carlo simulation techniques and includes an accepted mass flux provided by six main known meteor sources (i.e. orbital families of dust) and a detailed modeling of the meteoroid atmospheric entry physics. The results indicate, that although the Earths Apex centered source, composed of dust from long period comets, is required to be only about ~33% of dust in the Solar System at 1 AU, it accounts for 60 to 70% of the actual dust which enters the atmosphere. These particles are mostly characterized by very high geocentric speeds (~55 km/sec) since they are in retrograde orbits. The reminding 30% of meteoroids entering the atmosphere originate mostly from the Helion and Ant-helion sources. The results of the model are in excellent agreement with observed diurnal curves obtained at different seasons and locations. Based on these results, we calculate the micrometeor global, diurnal and seasonal input in the upper atmosphere.

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

JAS005 **Oral Presentation** **396**

Dynamics of an stratospheric aerosol during solar, magnetic and ionosphere activities on Kamchatka

Dr. Boris Shevtsov
Far Eastern Branch Russian Academy of Science IAGA

Vasilii Bychkov, Valerii Marichev, Andrei Perezhogin

By results of one frequency lidar sounding of atmosphere above Kamchatkadynamics of aerosol layers at night in a range of 10-70 km heights in comparison with the data of magnetic and ionosphere supervision is investigated. Correlations of aerosol density with solar, magnetic and ionosphere perturbation and mechanisms of stratospheric aerosol formation are considered. Estimations of spatial and time scales of aerosol layers are made. The role of stratospheric aerosol as an indicator of geophysical processes is discussed.

Keywords: lidar, atmosphere, erosol

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

JAS005 **Oral Presentation** **397**

Modeling of summer mesopause dynamics with LIMA

Dr. Uwe Berger
IAP Kuehlungsborn AGU IAGA

F.-J. Luebken, G. Baumgarten

This paper describes a new circulation model of the MiddleAtmosphere called LIMA (Leibniz-Institute Middle Atmosphere model)which aims to reproduce the most important features of the upperatmosphere, e.g. the thermal structure around the mesopause atvarious latitudes. LIMA is a fully non-linear, global, andthree-dimensional Eulerian grid-point model which extends from theground to the lower thermosphere (0-150 km) taking into accountmajor processes of radiation, chemistry, and transport. The major improvements of LIMA are the implementation of a triangular horizontal grid structure with 41804 grid points in everyhorizontal layer (delta x,y =110 km), and the assimilation of tropospheric and lower stratospheric data from ECMWF/ERA-40 (European Center for Medium-Range Weather Forecasts,Reading, England). This allows in middle atmosphere modeling toinvestigate in detail the effects of the lower atmosphere on theupper atmosphere through wave activity propagation. One of the important application by LIMA is the connecting of theLIMA data archive to noctilucent cloud modeling. Therefore our majorgoal is to simulate as precise as possible the observed thermaland dynamical state of summer mesopause region (80-95 km) at high latitudes. Besides temperature, winds and air density, water vapor is one additional key parameter which is essentially needed in ice cloud modeling. Ground based measurements of H2O with WASPAM at ALOMAR provide important boundary conditions for the water vapor abundance close to (but slightly below) NLC/PMSE altitudes. The comparison of LIMA results with WASPAM measurements in shows nice agreement and suggests that theresults from the LIMA chemistry/transport module, e.g. water vapor data, represent a reasonable input for NLC/PMSE modeling.

Keywords: summermesopausedynamics, nlcmodeling, mesosphericwatervapor

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

JAS005 **Oral Presentation** **398**

Meteor smoke particles studied with rocket and radar techniques

Dr. Markus Rapp

Optical Soundings and Sounding Rockets Leibniz Institute of Atmospheric Physics (IAP) IAGA

Meteor smoke particles (MSPs) are thought to be formed from the re-condensation of meteoric matter ablating at altitudes between 120 and 70 km. Available models of the generation and growth of MSPs predict peak number densities of ~1000/cm3 in the 80-90 km altitude range with corresponding mean particle radii in the low nanometer-range. Despite these tiny dimensions, it has been speculated that MSPs play a major role in a variety of mesospheric phenomena such as the nucleation of noctilucent clouds, the mesospheric metal atom chemistry, the transport of meteoric material to the ground, and the formation of niric acid trihydrate-particles in polar stratospheric clouds which are involved in the formation of the ozone hole. Hence, in view of their quite obvious potential importance it is stunning how little experimental evidence regarding the properties of MSPs is currently available. In this presentation we report results from the German-Norwegian-led ECOMA sounding rocket project (ECOMA = Existence and charge state of meteoric smoke particles in the middle atmosphere). We will introduce the particle detector (PD) design developed at the LeibnizInstitute of Atmospheric Physics in Germany. The PD is a combination of a conventional Faraday Cup with a Xenon-flashlamp which we used to actively ionize MSPs. Results from a campaign in September 2006 will be presented and thedependence of the particle chargeon thebackground plasma will be discussed. Furthermore, we will show that charged MSPs should alter the incoherent scatter spectrum which can consequently be used to inferinformation on MSP number densities and sizes. Results from measurements with different incoherent scatter radars will be presented and discussed in the light of the available in situ and model results.

Keywords: meteor smoke particles, in situ measurements, incoherent scatter

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

JAS005 **Oral Presentation** **399**

Instability of charged aerosol flow as a generation mechanism for electron density irregularities in mesosphere.

Mrs. Veronica Grach
Dept. Astrophysics and Space Plasma Physics Institute of Applied Physics, RAS IAGA

Victor Yu. Trakhtengerts, Andrei G. Demekhov

A dissipative instability of charged aerosol flow is studied as a possible generation mechanism for small-scale irregularities in electron density at mesopause altitudes. In summer periods such irregularities of different scales cause PMSE (polar mesospheric summer echoes), which have been widely investigated for the last 30 years. Our analysis is carried out taking into account a review of literature, devoted to experimental and theoretical study of PMSE, and the most recent published data concerning atmosphere composition and properties of aerosol particles at corresponding altitudes (80-90 km). The dissipative instability develops as a result of relative motion of aerosol and ion flows. Different factors influencing this interaction were taken into account, such as aerosol charging processes, the presence of suprathermal photoelectrons, elongate aerosol shape and possible presence of two distinct aerosol fractions, large and small ones. Dependence of the instability threshold on the medium parameters was investigated, and quantitative estimates of the parameters necessary for this threshold to be reached were made. Criteria of the dissipative instability in mesosphere are formulated as follows: - the presence of large spherical aerosol particles (typical radii 100-200 nm) or strongly elongate aerosols, which are directed along the flow; - high ion density with respect to electron density; - the ion component consisting of heavy ion clusters (typical mass 200-400 a.m.u.) - aerosol charge about 10-40 electron charges (such large charges can be reached during the diurnal maximum of the photoelectron flux). Under such parameters at mesopause altitudes the dissipative instability creates electron density irregularities with scales about 10-30 cm, i.e. the irregularities causing PMSE at UHF frequences. According to experimental data, conditions stated above are not typical for the mesopause region, but can be realized in some cases. So we can conclude that a development of the dissipative instability of charged aerosol flow could provide a generation of irregularities causing PMSE at UHF wavelengths.

Keywords: pmse, dissipative, instability

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

JAS005 **Oral Presentation** **400**

A New Interpretation of DROPPS Polar Summer Mesosphere Particle Data by the Inclusion of Off-Axis Variations

Dr. Phillip Webb
Goddard Earth Sciences and Technology Center University of Maryland, Baltimore County
IAGA

Dr. Richard. A. Goldberg, Dr. W. Dean Pesnell, Michael N. P. Assis

The two Black Brant payloads flown during the DROPPS (Distribution and Role of Particles in the Polar Summer Mesosphere) rocket program were launched during early July, 1999 from Andya Rocket Range. The purpose was to investigate the polar summer mesosphere, particularly polar mesospheric summer echoes (PMSE). Both DROPPS payloads included front mounted side by side Particle Impact Detector (PID) charge and mass telescopes. Computer simulations have shown that the PID telescopes have the potential to detect atmospheric ice particles within the mesosphere having dimensions of a few nanometers. Ice particles of nanometer size are believed to be responsible for PMSEs through the process of electron scavenging. Evidence for this process is suggested by the presence of an electron biteout observed in the same region as the observation of nanometer size particles at an altitude of ~ 82-87 km over Andya during the first DROPPS launch sequence. Evidence for this dusty plasma was observed independently by several instruments aboard the DROPPS payload. By comparing PID observations with the computer simulations we can obtain information concerning the properties of the PMSE particles, including their rocky core size, ice mantle thickness and size distribution. We have previously presented results from an analysis of the two detectors that suggested on the first flight particles with a radius of approximately 2 nm were present in the PMSE layer. We have now extended the computer simulation analysis from the one spatial dimensional along the central axis of the detectors to now include a radial component under the assumption that the detectors both have cylindrical symmetry. This allows us to understand the effects of variations in the off-axis electric field on the trajectories of the PMSE particles. This talk will introduce the findings from the new analysis.

Keywords: pmse, aerosols, mesosphere

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

JAS005 **Oral Presentation** **401**

NLC occurrence at mid-latitudes: General properties and dependence on ambient winds and temperatures

Dr. Michael Gerding
Optical Soundings Leibniz-Institute of Atmospheric Physics IAGA

Josef Hffner, Monika Rauthe, Werner Singer, Franz-Josef Lbken

At the mid-latitude location of Khlungsborn (54N, 12E) up to five NLC per year have been observed by lidar since 1997 (overall observation probability up to 12 %), showing that the atmospheric conditions for NLC are fulfilled only occassionally. Out of the total of 23.5 hours with NLC a mean NLC altitude of 83.0 km with a distribution half width of 1.2 km has been derived. Therefore, NLC above Khlungsborn occur nearly at the same altitude than at more polar locations, even though the mean temperature profile is strongly different. In general NLC at mid-latitudes are weak and only about 20 % show a backscatter coefficient of (532nm) > 410-10 m-1sr-1. We will present the mean characteristics of NLC at our location. Additionally, we will discuss the role of ambient temperature and wind direction for the existence of NLC in mid-latitudes. Since autumn 2002, the combination of Rayleigh/Mie and potassium resonance lidar at our location enables temperature measurements in the whole mesosphere and lower thermosphere. The soundings during the summers 2003 to 2005 reveal a minimum mesopause temperature of about 145 K at 87 km. At NLC altitudes the mean temperatures are mostly higher than ~155 K, therefore several Kelvin warmer than the frost point temperature. We will present time-dependent lidar soundings showing temperature variations of up to20 K due to gravity waves and tides. During NLC, our lidar soundings reveal temperatures below the frost point above the NLC and higher temperatures below. Unfortunately, temperature measurements directly within the NLC are inhibited by observational constraints. Recent soundings are complemented by wind observations of a co-located meteor radar. We will examine temperature and wind measurements during ice events as well as during supersaturated periods without ice. We will demonstrate that NLC observations are limited to periods with supersaturation and southward winds, while on the other hand both conditions are not sufficient for NLC existence.

Keywords: noctilucent clouds, lidar, temperature

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

JAS005 **Oral Presentation** **402**

Meteoric smoke

Prof. John Plane
School of Chemistry University of Leeds IAGA

Russell Saunders

About 50 tonnes of interplanetary dust enters the atmosphere each day at geocentric velocities of 11 72 km s-1. Most of the dust ablates to form gas-phase atoms and ions in the upper mesosphere and lower thermosphere (70 120 km). These atoms (principally Fe and Si) form compounds (e.g. FeOH, SiO2) which condense together over several days to form particles around 1 nm in radius. These particles are called meteoric smoke. This paper will present the results of a laboratory study to mimic the formation of smoke, using a photochemical reactor to generate Fe- and Si-rich particles by homogeneous nucleation in the gas phase. This reactor has been used to study the composition, morphology, light extinction properties, and formation kinetics of these smoke analogues. There are several important findings: 1), the particles have fractal-like, fluffy morphologies; 2), they grow very rapidly by magnetic dipole-driven agglomeration; and 3), they exhibit strong light extinction in the near-UV. The laboratory results are then incorporated into an atmospheric model to examine the proposed roles of meteoric smoke in the mesosphere and stratosphere: providing condensation nuclei for noctilucent and polar stratospheric clouds; heterogeneous processing of acidic gases such as HNO3 and H2SO4; and the cause of anomalous light extinction in the mesosphere, possibly linked to polar winter radar echoes. Finally, the paper will examine the theory that the paleoproterozoic and neoproterozoic glaciations were caused by the solar system moving through dusty interstellar clouds.

Keywords: meteor ablation, smoke particles, mesosphere

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

JAS006 **403 - 431**

Symposium
Electrodynamical and chemical effects in the middle and upper atmosphere generated by thunderstorms

Convener : Dr. Elisabeth Blanc, Dr. Fernanda Sao Sabbas
Co-Convener : Dr. Craig Rodger, Prof. Davis Sentman

Since humankinds dawn we have been intrigued by the way that solar and extra-terrestrial sources of energy affect our planet. The processes by which these extraterrestrial energy fluxes interact with the Earths magnetic field, impacting the outermost layer of the planet, the Magnetosphere, get transferred downwards to the ionosphere and consequently to the lower neutral atmospheric layers, have been the subjects of speculation and research for centuries. Only within the modern era of research, in the 1960s CE, was the first upwards form of energy and momentum transport originating in the Troposphere discovered in the form of gravity waves. Thunderstorms constitute the most significant source of gravity waves. Recently, in 1989, another process of upward transfer of thunderstorm energy, this time electrical, was discovered and dubbed a sprite. Since then, other forms of electrical energy transport to the upper atmosphere and space, also originating in thunderstorms, have been discovered. They can be broadly classified into two different categories: the Transient Luminous Events, TLEs; and the high energy bursts, e.g. Terrestrial Gamma-ray Flashes, TGF, and X-ray emissions, observed both by satellite instruments and, more recently, from the ground. Satellite observations of thunderstorm-related TLEs and TGFs have demonstrated that they are both global phenomena. TLEs in their totality span the distance from the lower atmosphere to the ionosphere. They mark the occurrence of electrical breakdown and ionization in the region above thunderstorms, and may occur at all latitudes. The principle mechanisms driving TLE formation and propagation have been determined to be akin to those of conventional tropospheric lightning, involving characteristic electron energies of the molecular ionization energy, a few eV. By way of contrast, the high energy TGFs appear to be largely a low latitude phenomena. They are also associated with thunderstorms, but possess a vastly smaller frequency of occurrence than TLEs. They appear to be produced by a runaway electron breakdown mechanism involving relativistic electrons accelerated in the thunderstorm electric field. Ongoing ground based triggered lightning experiments have detected gamma ray bursts associated with lightning leaders, suggesting that the underlying source mechanism may be similar to that of TGFs. This session welcomes papers on all the electrodynamical effects of thunderstorms on the upper atmosphere, their interaction with the local medium and the ionosphere, chemical effects, gravity wave interactions, possible coupling into the magnetospheric system, and all types of associated phenomena.

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

JAS006 **Oral Presentation** **403**

Day-Night Asymmetry Influence on Schumann Resonance Amplitude Records

Mrs. Olga Pechony
Geophysics and Planetary Scienses Tel Aviv University

Colin Price

Many research groups use ELF observations (Schumann Resonance transients) to estimate the charge moment, polarity and location of the parent lightning that trigger TLEs. However, at any moment this ELF radiation travels within a non-uniform waveguide due to the day-night hemispheres. How important is this asymmetry of the waveguide to the Schumann resonance (SR) records? Influence of the day-night asymmetry on Schumann resonances concerned researchers ever since the first interest in SR arose. Diurnal variations of the SR field power were the first well-documented features of the SR phenomenon. The observed variations were explained by the alterations in the source-receiver geometry and it was concluded that no particular systematic changes of the ionosphere are needed to explain these variations [Balser and Wagner, 1962, Madden and Thompson, 1965]. Subsequent theoretical studies supported these estimates [Bliokh et al., 1980, Field and Joiner, 1982, Nickolaenko, 1986, Rabinowicz, 1988, Nickolaenko and Hayakawa, 2002]. However the structure of the observed diurnal and seasonal variations of SR fields enhancement of amplitudes during the day-time with significant variations around sunrise and sunset in many records, gave strength to the hypothesis that SR amplitude records are significantly influenced by ionosphere day-night asymmetry [Sentman and Fraser, 1991, Melnikov et al., 2004, Williams and Satori 2004, Satori et al. 2006]. The effect of the day-night asymmetry on SR amplitudes is estimated to be approximately 10% both theoretically [Nickolaenko, 1986, Rabinowicz, 1988, Nickolaenko and Hayakawa, 2002, Pechony et al., 2006] and experimentally [Satori et al. 2006]. Analysis of experimental records show, in agreement with recent theoretical results [Yang and Pasko, 2006, Pechony et al., 2006], that both diurnal and day-to-day variability of SR amplitudes are significantly higher then the variations induced by the day-night asymmetry. It therefore appears that the global lightning activity plays a more significant role in the observed variations of SR amplitudes then the diurnal ionosphere conductivity changes.

Keywords: elf, lightning, ionosphere asymmetry

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

JAS006 **Oral Presentation** **404**

Coupling of thunderstorms to the stratosphere, mesosphere and ionosphere

Dr. Torsten Neubert
Department of Solar System Physics Danish National Space Center IAGA

Cal Team

During the past 4 years, the Research Training Network Coupling of Atmospheric Layers (CAL) has studied effects of thunderstorms on the upper regions of the atmosphere. The network has conducted observations over Southern Europe of a wide range of parameters related to electrical discharges in the mesosphere (sprites) and simulated aspects of the sprite discharge processes and their effects on the atmosphere and ionosphere. Observations point to significant energy deposition by sprites in the neutral atmosphere observed as infra sound detected at up to 1000 km distance. The important role of intra-cloud (IC) lightning in sprite generation has been made clear by the first simultaneous observations of IC activity, sprite activity and electromagnetic radiation in the VLF range. Sprites, elves and lightning significantly affect ionization and heating of the lower ionosphere/mesosphere as seen in signal characteristics in the VLF and HF range. Simulations of sprite ignition show generation of relativistic electrons that may be the source of Terrestrial Gamma-ray flashes. Model estimates of sprite perturbations to the atmospheric electric circuit, greenhouse gas concentrations and atmospheric dynamics show significant local perturbations, but negligible global effects. The presentation will give an overview of the results and look towards the future for European sprite research with the TARANIS and ASIM missions planned for launch in 2011.

Keywords: thunderstorms, mesosphere, discharges

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

JAS006 **Oral Presentation** **405**

On the Mechanism of Blue Jet Formation

Dr. Gennady Milikh
Astronomy University of Maryland

Yuri P. Raizer, Michael N. Shneider

A new model of blue jets as a lightning related phenomenon is proposed. A blue jet consists of the bi-leader, whose top part is seen on photos as a trunk of a tree, and is capped at the top side of the leader by its streamer zone. The latter is shown as tall and narrow branches of the tree. It is shown that the time independent fractal blue jet model does not provide an adequate description of blue jets and streamer zone of a leader. It ignores an important fact of the fast loss of the streamer channel conductivity due to the electron attachment to the oxygen. The top streamer branches were born mostly prior to the bottom branches not as result of branching, but formed by the leader tip. It was shown that due to transfer of the high potential of the edge of the thundercloud by the leader, long streamers of blue jets can be sustained by moderate cloud charge. The streamer length is estimated along with the height at which the streamers can reach the ionosphere. The propagation of a streamer in the atmosphere of exponentially falling density N and in the self-consistent electric field of the streamer zone was computed. It was found that the critical external field Es required for unlimited streamer growth satisfies the similarity law Es/N ~ const. The similarity law was numerically studied in a wide range of N.

Keywords: lightning, sprites, jets

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

JAS006 **Oral Presentation** **406**

Preliminary kinetic simulations of the transient electron driven air plasma chemistry stimulated by Sprites: impact on the formation of nitride oxides

Dr. Francisco J Gordillo-Vazquez
Institute of Optics CSIC IAGA

The understanding of the impact of Transient Luminous Events (TLE) on the chemistry of the mesosphere remains nowadays a subject of scientific debate. In particular, the microscopic kinetic mechanisms underlying the formation of very reactive species in the upper atmospheric discharges and their interaction with neutral components of the atmosphere remain not well understood. In this presentation, we will show preliminary results on a model of the transient air plasma chemistry generated by sprites. We will first describe the model built including the electron, neutral and ionic chemical paths taken into consideration. The model is based on the self-consistent time-dependent solution of a set of rate equations for each of the species considered coupled to a Boltzmann equation. The electric fields needed for these calculations are taken from recent altitude profiles of E/N associated to sprite events as estimated from ISUAL measurements. Finally, the simulations will give a first quantitative estimation on the impact of upper atmospheric transient discharges (sprites) on the formation of nitride oxides which role in the ozone cycle of the Earth might be important.

Keywords: sprite plasma chemistry, nitride oxides, mesosphere

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

JAS006 **Oral Presentation** **407**

Terrestrial gamma-ray flashes seen from orbit

Prof. David Smith
Department of Physics University of California, Santa Cruz

A discharge process associated with thunderstorms produces Terrestrial Gamma-ray Flashes. These millisecond bursts of high energy radiation produce ionization at all levels in the atmosphere. Both new data from the RHESSI satellite and new analyses of the original TGF data from the Compton Gamma-ray Observatory are rapidly improving our understanding of this phenomenon. I will review the most recent results from both observatories.

Keywords: gamma ray, breakdown, lightning

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

JAS006 **Oral Presentation** **408**

Observations of Burst-like VLF activity in association with sprites and correlations with intracloud lightning activity

Mr. Robert Marshall
IAGA

Umran S. Inan, Walter A. Lyons

Recent observations have revealed the occurrence of burst-like VLF activity, lasting from tens of milliseconds up to a few seconds, near the onset of many sprites. These "sferic bursts" are thought to be due to intracloud lightning activity, since they have been observed to only propagate short distances (a few hundred km) in the Earth-ionosphere waveguide and are generally not reported by the National Lightning Detection Network (NLDN). Such sferic bursts have been previously observed in association with early/fast VLF perturbations, and were then attributed to intracloud lightning activity. The possible involvement of intracloud lightning in sprite production has been previously suggested based on the observed long delays between causative CG discharges and sprite events. In this work, we investigate the correlation between sprites and sferic bursts using VLF and optical data from the past decade of sprite observations. In particular, a wideband (10 Hz - 20 kHz) VLF receiver was deployed in the summers of 1995 - 2000 at Yucca Ridge Field Station in Fort Collins, CO, while sprite observations were made from the same location. Additionally, more recent data from Langmuir Laboratory in 2005 are analyzed, which again provided co-located sprite and VLF measurements. We compare the occurrence of sferic bursts in association with sprites for thousands of sprite observations through many different dates and storms. Results indicate that sprites are more commonly found in association with bursts of sferic activity than those Cloud-to-Ground (CG) discharges without sprites, after accounting for peak currents. The data set in hand also allows comparative correlations with such metrics as VLF burst intensity and energy content; and sprite size, brightness, and multiplicity. Further, we investigate the source of these sferic bursts in terms of the types of intracloud and cloud-to-ground lightning that are responsible for the noise-like signatures. In particular, we use Lightning-Mapping-Array (LMA) data from New Mexico Tech in the summer of 2000 to show correlations with VLF bursts. We find that some, but not all, cases correlate with LMA data, and use this information to show that VLF bursts are more likely to be signatures of Q-trains of intracloud lightning, not measured by the LMA, and more strongly liked with low-altitude spider lightning.

Keywords: sprites, lightning, vlf

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

JAS006 **Oral Presentation** **409**

The TARANIS project - ELF/VLF signatures of TLEs at ground and on-board satellites

Dr. Francois Lefeuvre
IUGG CNRS IAGA

TARANIS (Tool for the Analysis of RAdiations from lightNIngs and Sprites) is a CNES microsatellite project whose the main scientific objective is the study of the physical mechanisms associated with the generation of TLEs (Transient Luminous Events) and TGFs (Terrestrial Gamma ray Flashes). The scientific payload is described. Its consistency with the scientific objectives is discussed. The emphasize is put on simultaneous EM signatures of TLEs recorded in the ELF/VLF frequency range at the ground-based Langmuir station and on-board the DEMETER satellite. Characteristic properties of ELF/VLF waves simultaneously received at the Nanay station and on DEMETER are discussed..

Keywords: parentlightning, sferics

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

JAS006 **Oral Presentation** **410**

Climatological Variations of upper atmosphere using Whistlers at low latitude

Dr. Ravindra Pratap Patel
Department of Physics Banaras Hindu University, Varanasi, India IAGA

Space climatology includes a description and understanding of the average properties and regular variations of the Sun Earth systems; description and analysis of probabilities of extreme events; and evaluation of long-term trends. At our low latitude station Varanasi a good amount of database of VLF whistler mode waves from 1990 onwards is available. The source of VLF wave is natural lightning discharges. Whistler activity varies with latitude having maximum around 500 geomagnetic latitude. The occurrence rate is low at low latitude and also depends on the solar and geomagnetic conditions. In this paper, we report the results derived from the statistical analysis of whistlers recorded at Varanasi during the period January 1990 December 1999. The monthly occurrence rate is obtained which shows maximum during January to March. Seasonal variation of the occurrence rate is also studies. In order to study the role of geomagnetic disturbances on the occurrence rate, we have used KP index and its variation. It is observed that the occurrence probability monotonically increases with KP values. It is observed that when KP > 10, the occurrence rate is greater than the average value. This tendency is found to be in good agreement with those reported by other workers. In addition we also present the probability of observation of whistler waves during the weak/intense geomagnetic storms. Detailed result of occurrence of whistler waves during the main phase and recovery phase of geomagnetic storms will also be presented. An attempt will be made to present explanation of these statistical results.

Keywords: whistlers, geomagnetic storm, lightnning discharge

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

JAS006 **Oral Presentation** **411**

Using the World Wide Lightning Location Network to investigate local time effects of strong lightning strokes on the lower ionosphere

Mrs. Erin Lay
Earth and Space Sciences University of Washington IAGA

Robert H. Holzworth, Abram R. Jacobson, Craig J. Rodger, Harald U. Frey, Richard L. Dowden

The World Wide Lightning Location Network (WWLLN) [Dowden et al., J. Atmos. Sol Terr. Phys. 64, 817-830, 2002] provides real-time lightning locations globally for the strongest lightning strokes by measuring the very low frequency (VLF) radiation emanating from lightning discharges. Strong lightning strokes have been shown in recent years to be linked to transient luminous events such as sprites and elves, as well as large variations in the electron density and conductivity in the lower ionosphere. In this work we focus on the effect of the lightning electromagnetic pulse (EMP) on the lower ionosphere and on elves. Since the magnitude of the EMP is dependent on peak current of the associated lightning stroke, and not on lightning type, it is important to monitor all types of lightning with strong peak current. While the detection efficiency varies regionally across the world, comparisons with other lightning detection systems show that the detection efficiency is constant in a given region for all types of lightning strokes (both in-cloud and cloud-to-ground) that have peak-current magnitudes above ~40 kA. For this reason, the WWLLN is a useful tool for producing global time-varying maps of the regions most likely to be affected by lightning EMP. We show that WWLLN can detect lightning strokes associated with elves all around the world by a comparison to elves detected by the ISUAL instrument on the FORMOSAT-2 spacecraft. Using WWLLNs continuous real-time coverage of high peak current lightning, we will analyze the local time variations of WWLLN-detected lightning events and discuss the implications of these variations on EMP effects of strong lightning on the lower ionosphere. We find that the peak of the distribution of strong lightning stroke count rates in local time varies by up to five hours in local time in different regions, indicating that the long-lasting effects on local electron density in the nighttime lower ionosphere could also vary regionally.

Keywords: lightning, elves, ionosphere

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

JAS006 **Oral Presentation** **412**

Relativistic Runaway Electron Avalanche Seeding Efficiency

Mr. Brant Carlson
Physics STAR Lab., Stanford University

Nikolai G. Lehtinen, Umran S. Inan

Relativistic runaway electron (RRE) avalanche breakdown occurs when the lower dynamic friction on relativistic electrons allows them to undergo avalanche multiplication while driven by smaller electric fields than those required for conventional breakdown. RRE avalanche has been suggested to be the driving physical mechanism for many processes, including lightning initiation, sprites, and terrestrial gamma-ray flashes (TGFs). The RRE avalanche has been studied extensively, but existing results typically assume a rudimentary source of seed relativistic electrons. In this paper, we focus on this seeding process and present detailed simulation results of various seeding conditions. The initial seed particle type, energy, and relative direction are varied, as are the ambient electric field and atmospheric density. Known results on the temporal and spatial distributions and flux and energy spectra of cosmic rays as well as other possible seed sources are incorporated. The seeding of RRE avalanche under quasi-electrostatic and electromagnetic pulse models (previously suggested for TGF and sprite production) are also included. The efficiency of seeding under these circumstances and the effects of seeding structure on RREA spatial and temporal structure are discussed.

Keywords: relativistic breakdown, tgf, sprite

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

JAS006 **Oral Presentation** **413**

Submillisecond Video and Electromagnetic Observations of TLE Development and Structure

Prof. Steven Cummer
Electrical and Computer Engineering Duke University IAGA

Jingbo Li, Walter A. Lyons, Thomas E. Nelson

During a summer 2005 observation campaign at Yucca Ridge, Colorado, numerous instruments aimed at observations of high altitude optical emissions driven by lightning. Included in this set were a flexible intensified high speed camera (Vision Research Phantom 7.1) and wideband magnetic field sensors (0.1 Hz to 30 kHz, built by QUASAR, Inc.) that were employed in an effort to probe the details of the connection between the low altitude lightning processes and high altitude transient luminous events (TLEs). The low frequency sensitivity of the magnetic field sensors enabled measurement of the continuing lightning current that is involved in many of the complex sprites but that can be difficult to detect by other means, while the high speed video gave precise timing of TLE onset and features relative to the driving lightning processes below. A total of 76 TLEs were captured on high speed video during this campaign; 10 were halos or elves without sprites, and 66 were sprites, many of which were also accompanied by halos and elves. Sprites were imaged between 5000 and 10000 frames per second on 13 August 2005 during a storm that was as close as 250 km from the camera. The combination of proximity and camera speed revealed a detailed view of the spatial and temporal development of the sprites observed on this night. Some new features were also seen; for example, it appears that at least some sprite beads with persistent optical emissions form when a downward streamer head collides with an adjacent, preexisting streamer channel. We also analyze a variety of different mesospheric optical emissions, from time resolved elves and halos to complex, long duration sprite sequences.

Keywords: lightning, sprites, vlf

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

JAS006 **Oral Presentation** **414**

TLE influence upon the neutral chemistry of the upper atmosphere

Dr. Craig Rodger
Department of Physics University of Otago IAGA

Annika Seppl, Mark A. Clilverd

For many years it has been suggested that transient luminous events (TLE) occurring over thunderstorms may produce significant modifications to neutral atmospheric chemistry. It has been known for some time that red sprites, one type of TLE, involve very large increases in ionisation density at altitudes of ~70-80km. Some have speculated that such ionisation increases could result in enhancements of odd nitrogen (NOx = NO + NO2), which play a key role in the ozone balance of the middle atmosphere because they destroy odd oxygen (Ox = O + O3) through catalytic reactions. In this study we make use of nighttime NO2 observations by the GOMOS instrument on the Envisat spacecraft to test whether TLE are producing significant NO2 enhancements in the middle atmosphere.

Keywords: red sprite, thunderstorm, odd nitrogen

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

JAS006 **Oral Presentation** **415**

Modeling the influence of a high altitude discharge on the chemical balance of the mesosphere

Mr. Andrey Evtushenko
IAGA JAS006 IAMAS

The study of chemical balanceof the middle atmosphere is one of the most important problems of modern geophysics. Among the important and still poorly understood factors influencing the chemical balance at these altitudes, fine aerosols and high altitude discharges, such as elves, sprites and jets, can be noted. Recent researches gave evidence that a sprite discharge provides increasing of electron temperature and electrical field at mesospheric altitudes. As the rates of many chemical reactions depend on the above mentioned parameters, sprites provide the variations in excited atoms, molecules and charged-particle composition. We have developed a plasma-chemical model including 200 reactions and 50 chemical components. The components most sensitive to variations of external parameters have been determined. Particularly, electrons, atomic nitrogen N, molecular ions O2+and NO+, excited molecules O2(1Δg) have a big relaxation time, while molecular and atom ions N2+,O+,O-have a relaxation time much smaller than 1 second. Wehave analyzed the lifetime of disturbances which appeared to be as big as 0.01-500 seconds that proves the feasibility of disturbance accumulation at subsequent sprite flashes. It is of great interest taking into accountan evidence that positive cloud-to-ground lightning flashes and sprites may appear as often as several per minute for most intensive thunderstorm systems.The results of numerical modelingcan be summarizedas follows:1) Due to the increase of electron growth rate and decrease of electron recombination rate during the sprite discharge electron density is perturbed substantially (for instance, from 4000 cm-3 to 28000 cm-3 for daytime conditions, or from 50 cm-3 to 7000 cm-3 for nighttime conditions) .2) The relaxation time of electrons is about 10 seconds. Its in aagreement with indirect measurements, which shows that relaxation time of electrons on these heights should be between 1 and 10 seconds.3) Not all the densities of chemical components depend on the sprite discharge.The change of many components is very small. Also we find some chemical components which appear during the sprite discharge, but have a very small life time.4) As one of useful results of plasma-chemical modeling, a few chemical reactions have been distinguished providing the main contribution to sprite-sensitive component perturbations.5) Our mumerical modeling was performed neglecting the diffusion and spatial irregularity of the discharge region. Estimations show however that these factors can be important and will be taken into account further.

Keywords: sprite, thunderstorm, chemistry

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

JAS006 **Oral Presentation** **416**

Mesospheric electric fields associated with lightning discharges, and some of their consequences

Prof. Michael Rycroft
IAGA

A. Odzimek, A. Kulak, R. L. Iwanski, N. F. Arnold

We consider electrical models of thunderstorms producing cloud-to-ground and intra-cloud lightning discharges. The height profiles of the electric field above a thunderstorm during and after such lightning discharges are simulated using a commercially available software package, PSpice A/D. These electric fields determine whether conditions above the thunderstorm are favourable for the initiation and development of high-altitude discharges, such as sprites. Our aim is to study the magnitude and the vertical structure of the quasi-static electric fields in the middle and upper atmosphere produced by such tropospheric discharges, and to search for the necessary conditions which lead to the occurrence of high-altitude discharges. Further, we estimate some different effects which these phenomena produce in the global atmospheric electric circuit.

Keywords: atmosphere, electricity, sprites

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

JAS006 **Oral Presentation** **417**

Long recovery early/fast events as possible evidence of persistent ionization by giant blue jets

Prof. Umran Inan
Space, Telecommunications and Radioscience Laborat Stanford University

Benjamin R. T. Cotts, Nikolai G. Lehtinen

A new class of Early/fast VLF events with unusually long (>20 minutes) recoveries may constitute evidence for possible persistent ionization by gigantic blue jets. The possible production of persistent ionization at low altitudes (h<70 km) by gigantic jet events was considered by Lehtinen and Inan [2007], using a new five constituent model of stratospheric/lower-ionospheric chemistry. Results indicate substantial ionization at h<50 km, which may be observable in subionospheric VLF data in the form of Early/fast amplitude and/or phase perturbations and exhibit an initially rapid (few seconds) recovery due to electron attachment, followed by a long enduring recovery (>10 minutes) determined by the time scale of mutual neutralization of negative and positive ions. Analysis also indicates that electrons may sometimes be quickly (<1 ms) removed by the dissociative attachment mechanism in the presence of a high electric field, while the negative and positive ions remain and persist for extended periods of time. In such cases, the initial rapid recovery may not be observable in VLF data due to its typical time resolution of ~10 to 20 ms. In the stratosphere h<50 km) the ionization recovery is found to not be accurately described by a four-constituent model proposed by Glukhov, Pasko, and Inan [1992, hereafter referred to as GPI] necessitating a fifth constituent, namely the heavy negative ions with high electron affinity (NX-). These type of theoretically predicted behavior are indeed exhibited by a new class of Early/fast VLF events with unusually long (>20 minute) recoveries, which sometimes also exhibit the initial rapid recovery. Three different types of such long recovery events have been documented [Cotts and Inan, 2007], with properties consistent with persistent ionization at altitudes below 60 km altitude. Preliminary occurrence statistics of such events indicate a preference for them to occur more commonly on all-sea-based paths, also consistent with few observations of gigantic blue jets being over oceanic regions.

Keywords: vlf, early fast, ionization

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

JAS006 **Oral Presentation** **418**

The chemical impact of transient luminous events in the middle atmosphere

Dr. Carl-Fredrik Enell
Sodankyla Geophysical Observatory University of Oulu IAGA

Enrico Arnone, Olivier Chanrion, Toru Adachi, Pekka T. Verronen, Annika Seppl, Torsten Neubert, Thomas Ulich, Esa Turunen

As tropospheric discharges (namely lightning) are an important source of odd nitrogen (NOx), we here address the question whether high-altitude discharges, such as red sprites and blue jets, may be a significant source of NOx or other chemical species. A well-established coupled ion-neutral chemical model, the Sodankyl Ion Chemistry (SIC) model, has been extended for this purpose. Input data to the model are rates of ionisation, excitation and dissociation of nitrogen and oxygen. We estimate these both by means of a streamer model and from optical observations. Due to large uncertainties both in available reaction rates and the aforementioned input data, this approach gives only order-of-magnitude estimates of the possible enhancements. The SIC modelling shows that a sprite-induced NOx enhancement by up to 3 orders of magnitude over the background is not unreasonable in the regions directly affected by streamers. Taking into account the lightning rate of present-day Earth, this source would be globally insignificant. This result is supported by present efforts to detect evidence of sprite-induced NOx in satellite data (e.g. Arnone et al. and Rodger et al., this session). The results are nevertheless of some interest for parameterising local effects in mesoscale models and also potentially for understanding the atmosphere of early Earth and other planetary atmospheres.

Keywords: transient luminous events, odd nitrogen

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

JAS006 **Oral Presentation** **419**

Balloon electric field measurements in the vicinity of an active convective storm

Dr. Jean-Jacques Berthelier
CETP IPSLCNRS IAGA

F. Simoes, M. Godefroy, S. Yahi, E. Seran, Jean-Pierre Pommereau, P Franois, J-L Maria

In the course of the AMMA campaign measurements of the vertical atmospheric electric field have been performed by the AIRS experiment onboard a stratospheric balloon flight launched from Niamey (Niger). Included in the same flight chain were several other instruments to measure atmospheric composition and clouds as well as optical sensors on the AIRS gondola to detect lightning. The AIRS experiment mainly aimed at observing tropospheric and stratospheric electrical processes in the vicinity of active convective system, looking for possible effects of lightning on atmospheric chemistry in the lower stratosphere. The AIRS electric field instrument is a double-probe sensor which measures the vertical component of the atmospheric electric fields from DC to 4 kHz and the electrical conductivity of the atmosphere. It can also provide information on charged aerosols by detecting the potential disturbances induced by their impact on the electrodes or on the gondola. The flight occurred in the late afternoon of August 7, 2006 with ~ 1 hour at the ceiling altitude of 23 kilometres.During the ascent the balloon was far from any active cloud and the DC atmospheric electric field and conductivity profiles were rather typical of fair weather conditions. In the last part of the flight, the balloon drifted in the vicinity of a convective cell with moderate dimensions and activity as observed from meteorological radar data. Numerous lightning were detected by the optical sensors, most of them probably due to cloud to cloud discharges of moderate intensity. Their signatures on the electric field data that mix both impulsive effects due to the generated EM wave and slower variations due to the rearrangement of electrical charges within the clouds will be presented. Small scale electric field variations and turbulence were observed between ~ 11 km altitude up to the tropopause at 16.5 km that can be interpreted as resulting from the crossing of charged cirrus clouds. More interesting is the detection of similar disturbances in the electric field above the tropopause indicating the existence of thin cirrus layers also detected by an atmospheric sensor on the same balloon flight.

Keywords: atmospheric electricity, lightning

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

JAS006 **Oral Presentation** **420**

Air Chemistry of Sprite Streamers

Prof. Davis Sentman
Geophysical Institute University of Alaska IAGA

H. Stenbaek-Nielsen, G. Mcharg, J. Morrill

The physical picture of sprite streamers in the mesosphere revealed by high speed (10 kfps) optical imaging [McHarg et al., GRL, 2007] is that they consist ofbright (~100 MR) compact (~10s m dia)heads that descend at high speed (~1e7 m/s) across a distance of several tensof km.The ionization phase of a parcel of air affected by the passage of the streamer head persists for only a few microseconds. This talk presents the results of a study of theair chemistryassociated witha sprite streamer at 70 km altitude based on these observations.The basic sequence of eventsappears to bethe following: (1)ionization of N2/O2 producing an electron density of ~1e6/cc and optical brightness in 1PN2 of ~100 MR,creation of O- by dissociative attachment, creation of N(4S)/N(2D) and O(1D) by dissociation, and creation ofO2(a,b), all by electron impact in the streamer head during thefew microsecond interval of head passage; (2)following passage of the head, rapid (~ms) charge exchange ofN2+ with O2, effectively removing N2+ from playing a role in subsequent chemistry, (3) removal of electrons within the trailing streamer channel by dissociative recombination with O2+ and three body attachment with O2 over a period of several seconds. The principal result of the calculation is that the reignitionofsprites that has been observed in 1000 fps images[Stenbaek-Nielsen et al., GRL, 2000] appears tobe from remnantpatches ofcold electrons fromold sprite tendril channels. Additional results are that a modestenhancement of ambient NO occurs within the streamer channel, and that positive and negative ions produced as part of the streamer process may provide the seeds for subsequent creation of cluster ions.

Keywords: sprite, chemistry, thunderstorm

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

JAS006 **Oral Presentation** **421**

Seeking sprite-induced signatures in remotely sensed middle atmosphere NO2

Mr. Enrico Arnone
Physics and Astronomy University of Leicester

Antti Kero, Carl-Fredrik Enell, Bianca Maria Dinelli, Massimo Carlotti, Marco Ridolfi, Esa Turunen, Neil F. Arnold

We present the preliminary results of a study that seeks evidence of changes in the middle atmosphere NO2 that can be related to sprite activity. This study is motivated by the current understanding ofthe streamer nature of sprites: streamers are known to produce nitrogen oxides, thus sprites are expected to lead to a local enhancement of the background abundances. However, because of the altitude and rarity of these phenomena, to date no observational evidence of these changes have been reported. We adopt the following strategy: middle atmosphere MIPAS/ENVISAT satellite NO2 observations are correlated with tropospheric lightning activity from the WWLLN ground network. The transport of the hypothetical sprite-produced NO2 was taken into account using ECMWF winds. Since sprites occur during strong thunderstorm activity, a correlation between middle atmosphere NO2 anomalies and lightning activity could be evidence of nitrogen oxide production by sprites. Preliminary results suggested a small but statistically significant enhancement of nitrogen oxide. However, a thorough analysis proved similar enhancement could be reproduced in a Monte Carlo experiment. This could be due to the modest size of our dataset, having only about 500 MIPAS NO2 measurements in coincidence with lightning activity in the period August 2003 to January 2004 (when both datasets are available). Our results give a hint of changes and encourage an improvement of the study with future more extended datasets.

Keywords: sprite, satellite, nox

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

JAS006 **Oral Presentation** **422**

TLE Producing Storms over Argentina Observed from Brazil: Analysis of the IR Cloudtop Temperatures and Comparison with US Case Study

Dr. Fernanda Sao Sabbas

Aeronomy Division Instituto Nacional de Pesquisas Espaciais - INPE IAGA

Pierre-Dominique Pautet, Michael J. Taylor, Matt J. Bailey, Natalia Solorzano, Thomas Jeremy, Robert H. Holzworth, Steven Cummer, Nicolas Jaugey, Osmar Pinto, Nelson J. Schuch, Marcos Michels, Vinicius T. Rampinelli

On the night of February 22-23, and March 03-04, 2006 we observed more than 500 TLEs produced by massive thunderstorms over <st2:place w:st="on">Northern Argentina</st2:place>. The observations were performed during a sprite-balloon campaign conducted in , resulting of collaborative projects between the Brazilian and American research institutions listed in the Affiliations. We were located at the INPE Southern Space Observatory SSO/CRS, (29S, 53W), located at So Martinho da Serra, at the center of <st2:city w:st="on">Rio Grande</st2:city> do <st2:place w:st="on"><st2:placename w:st="on">Sul</st2:placename> <st2:placetype w:st="on">State</st2:placetype></st2:place>, the Southern most State of Brazil. We will present the cloudtop temperature analysis of the TLE producing thunderstorms based on GOES-12 data. The results involve the spatial-temporal evolution of the storm, location of the sprite/TLE and lightning producing regions and sprite/TLE lightning association. The lightning data analyzed are from World Wide Lightning Location Network (WWLLN) that detects the most intense discharges produced by the thunderstorms. Polarities of these discharges were determined by an ELF-VLF sensor installed at the observation site during the campaign. The results are compared with the paper So Sabbas and Sentman [2003], where a sprite producing storm over the central was observed during the night of July 22, 1996. So Sabbas, F.T. and <st2:place w:st="on">D. D.</st2:place> Sentman, Dynamical Relationship of IR Cloudtop Temperatures With Occurrence Rates of Cloud-to-Ground Lightning and Sprites, Geophys. Res. Lett., 30 (5), 40-1-40-4, 2003.

Keywords: sprites, tles, cloudtop temperature

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

JAS006 **Oral Presentation** **423**

Terrestrial Gamma-Ray Flashes and Very Low Frequency Data

Mr. Morris Cohen
Electrical Engineering Stanford University IAGA

Umran S Inan, Ryan K Said, David M Smith

Since their discovery by the BATSE spacecraft, and subsequent observation by the RHESSI spacecraft in much larger numbers, Terrestrial Gamma-ray Flashes (TGFs) have remained an area of great interest on the relationship between high electric fields associated with lightning, and highly relativistic acceleration of particles in the atmosphere. ELF/VLF data can detect the radio atmospherics from the associated lightning strokes, at global distances, and is sensitive enough to rule out the presence of medium or strong lightning strokes around the RHESSI-nadir in some situations. However, TGF locations are not known so much as the location of RHESSI at a give time, which has constrained spectroscopic, meteorological, and other studies of TGFs, as well as clouding questions of global occurrence rates and others. VLF techniques can localize the lightning stroke with high accuracy, utilizing precise GPS timing and time of arrival, as well as VLF dispersion anaysis, and magnetic direction finding. In addition, broadband VLF can describe some properties about the stroke (like peak current) and the more general thunderstorm. Narrowband VLF data can characterize any ionospheric signatures of TGFs (like Early/Fast events that are associated with sprites), by monotoring the amplitude and phases of sunionospherically propagating VLF transmitter signals. Earlier results have already distinguished some properties of TGF-associated lightning, for instance, that they tend to have the larger peak currents from a thunderstorm, and that there appear to be regional variations in the TGF-VLF connections, perhaps more specifically relevant to land/ocean lightning. In this presentation, the more finalized results of a comprehensive search through Stanford Universitys VLF data are presented. Specific attention will come on a growing new class of TGFs that have been accurately triangulated with Stanfords global receiver network, with the results are utilized alongside RHESSI data for spectroscopic and other studies. Due to the sensitivity of Stanford's ELF/VLF data, it is possible in some cases to rule out the presence of certain lightning strokes in the region around RHESSI for a certain time periods surrounding the TGF, and discuss the possibility of a geomagnetically conjugate source event.

Keywords: lightning, vlf, tgf

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

JAS006 **Oral Presentation** **424**

Occurrence conditions of TLEs

Dr. Yukihiro Takahashi
Department of Geophysics Tohoku University IAGA

Toru Adachi, Hiroshi Fukunishi, Shogo Chikada, Akihiro Yoshida, Satoshi Kondo, Rue-Ron Hsu, Han-Tzong Su, Alfred Bing-Chih Chen, Stephen B. Mende, Harald U. Frey, Lou-Chuang Lee

One of the most important targets in TLE study is to determine the occurrence conditions of TLEs. Since the first discovery of TLEs, a great deal of efforts have been made to establish their generation mechanism and to estimate the threshold of physical parameters which determine the occurrence. In regard to sprites, quasi-electrostatic (QE) model is broadly accepted as a principal idea. However, there remain some issues to be investigated about this simplified explanation. The occurrence threshold of charge moment predicted by QE model seems somewhat larger than actual measurements. And the actual threshold is not so sharp in observational results, implying another conditions that influence its occurrence. One candidate is the horizontal component of electric currents in thunderclouds, which cannot be detected directly on the ground. Ohkubo et al. (2005) and van der Velde et al. (2006) suggested that intra-cloud discharges including horizontal component play an important role in producing sprites. Another factor that should be considered would be the electric magnetic pulse (EMP) emitted from lightning channels. The significance of EMP in forming columny sprite is suggested by Adachi et al. (2004). As for generation of elves, EMP is considered as essential mechanism. However, according to the results obtained by ISAUL/FORMOSAT-2 and MEIDEX campaign, there exist some variations of its shape, including not only the doughnuts shape recognized since the discovery but also asymmetric disc-like structure. This fact implies tilted lightning channel is also one of the typical source of elves. Taking into account these facts, in order to know the occurrence condition of TLEs we need to examine the horizontal components of parent discharge in thundercloud in a wide frequency range relating to EMP power and charge moment. Another subject to be considered in TLE generation mechanism is the time constant of parent lightning discharge. Adachi et al. (2007) clearly showed that the time development of charge moment in parent lightning determines the types of emissions, namely, sprite halo, sprite streamer and their mixture. It is also found by Chikada et al. (2006) that TLEs have different rising and falling period of lightning current in TLEs. In this presentation, we will show the latest overview of the occurrence conditions of TLEs inferred from ISUAL and balloon experiment in Japan, combined with ground-based ELF/VLF measurements.

Keywords: tles, occurrence, condition

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

JAS006 **Oral Presentation** **425**

Planetary Equatorial Waves, Typhoons/Hurricanes, and Terrestrial Gamma-Ray Flashes: What do they have in common?

Dr. Robert Roussel-Dupre
Earth and Environmental Sciences Division Los Alamos National Lab IAGA

Zhen Huang, Douglas Revelle, Jonah Colman

Recent work performed at Los Alamos National Lab suggests a link between Terrestrial Gamma-Ray Flashes (TGFs) and the activity of Atlantic hurricanes and Northwestern Pacific typhoons during 2002-2005. An analysis of TGFs detected by the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) reveals a good correlation between the number of Atlantic hurricanes (Northwestern Pacific typhoon) and the number of TGFs during hurricane/typhoon season. In addition, TGF events follow, on average, to the southwest of the corresponding seasonally averaged hurricane/typhoon track. Cases of individual hurricanes/typhoons have been found where 4-to-7 consecutive TGFs occurred to the southwest of the corresponding individual hurricane/typhoon track 2-to-10 days after the hurricane/typhoon formation. A GOES satellite image taken around the peak intensity time of typhoon Pongsona shows the existence of a series of tropical perturbations from the Indonesian Equatorial Pacific region to the west bank of the Bay of Bengal. Given the RHESSI satellites 500 km detection radius, the traveling tropical perturbation track falls within the real-location of the TGF propagation track. Further investigation indicates that there are two tropical perturbation systems, one is responsible for the generation of the typhoons, and the other is the source of TGF occurrence. Both systems originated from the equatorial tropical Pacific where the one producing typhoons and the one linked to TGFs have different paths. However, the large-scale tropical atmospheric conditions are favorable for both, that is, typhoon activity and TGF occurrence should share the same tropical atmospheric conditions that are satisfied during the same period of time. In this presentation we review the evidence for a link between planetary equatorial waves, typhoons/hurricanes, and TGFs. Atmospheric density perturbations associated with acoustic gravity waves in a thunderstorm were incorporated in a fully electromagnetic runaway electron discharge model and the resulting gamma ray emissions were calculated and propagated to a satellite sensor. The results will be presented along with a comparison against the measured RHESSI spectra. The implications for actual source heights will be discussed and compared with height determinations for TGF events correlated with RF pulses. The association of infrasound with sprites will be discussed in light of our findings.

Keywords: lightning, runaway, meteorology

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

JAS006 **Oral Presentation** **426**

Global lightning distributions in high time and space resolution

Prof. Robert Holzworth
IAGA IAGA

E.H. Lay, C. J. Rodger, R. L. Dowden

Until recently studies of global lightning activity have depended on ground based techniques (cavity resonance frequency measurements) or on satellite measurements of lightning locations. The cavity resonance (Schumann Resonance) measurements do not provide highly accurate location information, while the satellite measurements from low Earth orbit can only observe a very small portion of the globe at any instant of time. Now we have global lightning detection being conducted in real time by a network of VLF receivers called the World Wide Lightning Location Network (WWLLN, see webflash.ess.washington.edu). The WWLLN locates lightning with a spatial accuracy of about 10 km, and a temporal accuracy of tens of microseconds. This talk will describe high resolution (space and time) distributions of global lightning patterns detected over the last three years by WWLLN. The WWLLN generates over 10^5 locations per day, making a total 3 year data set with approximately 10^8 data points. These data are relevant to scientific studies from upper atmospheric lightning dynamics and ionospheric plasma physics to studies of global weather variations. Research using WWLLN data for various direct applications will be summarized.

Keywords: lightning, location, global

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

JAS006 **Oral Presentation** **427**

Investigating Sprite Halo Optical Signatures and Associated Lightning Characteristics over South America

Dr. Michael Taylor
Center for Atmospheric and Space Sciences Utah State University IAGA

S. Cummer, J. Li, F. Sao Sabbas, J. Thomas, R. Holzworth, O. Pinto, N. Schuch

As part of the Brazil Sprites II balloon campaign ground-based measurements were conducted from the Southern Space Observatory (SSO) near Santa Maria, (29.4 S, 53.8 W) during the summer 2006. Remarkably, over 500 transient luminous events (TLEs) were imaged from two large thunderstorms located over north-eastern on February 22-23 and March 3- 4 2006. The optical observations were made using two intensified CCD cameras arranged to view the low elevation sky with overlapping fields of view to capture the TLE information from the extensive storm systems. This paper focuses on the optical characteristics of well over 100 sprite halos and their associated polarity and charge moments as determined by an ELF-VLF lightning sensor also deployed at the SSO. Recent satellite measurements of halos over land-sea interfaces suggest that they are mainly associated with negative cloud-to-ground discharges. The prime location of our coordinated measurements centered over the Pampas of South America has enabled us to quantify the polarity of the halos and to study their associated charge moments. The halo events measured to date are overwhelmingly associated with positive events, however at least one spectacular negative sprite-halo was also measured.

Keywords: sprite halo optical signature

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

JAS006 **Oral Presentation** **428**

Report of Poster Session coordinator

Dr. Fernanda Sao Sabbas
Aeronomy Division Instituto Nacional de Pesquisas Espaciais - INPE IAGA

Report of Poster Session coordinator

Keywords: report, poster, session

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

JAS006 **Poster presentation** **429**

Coupling into the magnetosphere caused by the lightning-induced acoustic-gravity wave

Dr. Sergei Shalimov
IAGA

Nikolai Erokhin

It is shown that acoustic-gravity wave caused by the lightning can be transformed into whistler wave in weakly ionized inhomogeneous plasma of the lower ionosphere. Theoretical treatment of the ionospheric magnetic field disturbance amplification under the action of acoustic-type shear-driven source term is presented. The nonlinear equation was obtained and analytically solved, and the amplification coefficient was calculated. Consequence of the whistler wave propagation into the magnetosphere is also discussed.

Keywords: electrodynamics, acoustic gravity, whistler

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

JAS006 **Poster presentation** **430**

Observational and Numerical studies of Winter Thunderstorms with Positive C-G lightning over the Sea of Japan

Mr. Syugo Hayashi
Forecast Research Department Meteorological Research Institute JMA IAMAS

Observed winter lightning on the Sea of Japan includes high percentage (> 40%) positive lightning over winter season. Some of these positive lighting has a relationship with "Sprite". However, the reason why winter lightning charged positively is not cleared. This study tries to clear the winter lightning polarity bias by using lightning observations and numerical simulations. In the statistical analysis by using a cloud-resolving model, there are no differences of the cloud temperature and the cloud-top height between the positive lightning case and the negative lightning case. Updraft increases the order as follows: no lightning In the Case Study by using 1.5km-CRM with lightning simulation, the positive case has strong positive regions, which is consists of of positive snow / cloud-ice and negative graupel, at the lower part of the cloud. Positive lightning is generated from this region. It is notice that positive winter lightning occurs for the following processes: 1. Positive charged snow / cloud-ice generated in cold region (upper part of a cloud) and fall down to lower part of the cloud, 2. Negative charged graupel generated warm region (lower part of the cloud), 3. Positive charged particles accumulate lower part of the cloud, 4. as a result of this accumulation increases positive lightning.

Keywords: positive lightning, winter thunderstorm

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

JAS006 **Poster presentation** **431**

The phase spectra approach to the analysis of Schumann resonance (SR) transients

Mrs. Adriena Ondraskova
Dept of Astronomy, Physics of Earth and Meteorolog Faculty of Maths, Physics and Informatics IAGA

Pavel Kostecky, Sebastian Sevcik, Ladislav Rosenberg

The Schumann resonances (SR) are the electromagnetic oscillations in the Earth-ionosphere resonator in the ELF frequency band that are permanently excited by world-wide lightning activity. In the time domain the Schumann background (noise-like) signal reflects the cumulative effect of many random independent lightning discharges. Over this background signal, the transient signals of substantially higher magnitude frequently occur. Some of them are well-known Q-bursts, generated by huge isolated discharges, mostly over the sea. Because the excitation sources of such transients possess simple space and time structure, they can be taken for a sort of sounding signals, usable for the Earth-ionosphere resonator properties modelling. At the Astronomical and Geophysical Observatory of Comenius University near Modra, western Slovakia, during more than four years of almost uninterrupted monitoring of the vertical electric component of SR, a number of transient signals were detected and stored for subsequent analysis. Two main problems are to be solved: (1) the reliable detection of high frequency SR oscillations (in the frequency range 40 100 Hz); (2) the confirmation whether the transient was excited by a true single source or by a small number of phase coherent sources. During spring and autumn 2006, a number of transient data time plots and spectra were collected. The short, but substantial description of the equipment in use for SR monitoring is given. The both time plots and amplitude spectra were used for the transient classification. This is demonstrated in several examples. It is shown that short-time phase spectra represent a very useful and powerful tool for analysis and the determination of principal SR mode parameters. Similar approach has not been used till now in the SR investigations. A new class of transient events is presumed to be found the events possessing the characteristic internal time delay corresponding to one orbit of wavefront around the Earth, but almost without the attenuation and frequency dispersion. We preliminary attribute these transients not to a single source (discharge) but to the Earth-ionosphere resonator response to more sources nearby. These sources (discharges) must be in some sense mutually synchronized (or triggered) for preserving the observed phase coherence between each other. A synchronization by means of the electromagnetic wave orbiting the Earth can be presumed as a suitable physical mechanism, which was anticipated by a genius of Nikola Tesla about 100 years ago.

Keywords: schumann resonances, q burst transient, phase spectrum

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

JAS007 **432 - 492**

Symposium
Response of the atmosphere/ionosphere coupling system to forcing from the Sun and the lower atmosphere

Convener : Dr. Dora Pancheva
Co-Convener : Prof. Edward Kazimirovsky

The variability in solar radiation and the particle flux from the Sun and the magnetosphere represent a large source of energy for the middle atmosphere, thermosphere and ionosphere. At the same time the mesosphere-lower thermosphere (MLT) and even ionosphere are driven from below by both dynamic and electrodynamic inputs from the massive lower atmosphere. The MLT region is a critical region in the coupling between the lower/middle atmosphere and the upper atmosphere/ionosphere since it is here that physical processes filter and shape the flux of waves ascending through the mesosphere into the overlying thermosphere. Most of these waves (planetary waves, atmospheric tides and acoustic-gravity waves) originating in the lower atmosphere are particularly strong and ubiquitous features in the MLT region and can influence ionosphere as well. On the other hand it is reasonable to presume that there might be a link between solar variability and the changes in the middle atmosphere and climate variables. This requires much improved knowledge and understanding of the solar effects on the coupling processes. The symposium will cover all aspects of the worldwide activity concerning the external forcing of the middle atmosphere and meteorological effects on the ionosphere. It will address the both theoretical and empirical recent results concerning the coupling mechanisms through dynamics, composition and electrodynamics i.e., solar influence in the middle atmosphere, transfer of momentum and energy by internal atmospheric waves, the interaction between these various waves, forcing of the ionosphere from below, the dependence of coupling processes on the solar and geomagnetic activity, the downward control effects transferring from the strongly solar dependent structure to the lower atmospheric levels.The symposium will serve as a forum for the discussions of ongoing efforts including improvements and new additions to databases, interpretations, simulations and theoretical models

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

JAS007 **Oral Presentation** **432**

Influence of the Solar Cycle on the Residual Mean Circulation of the Middle Atmosphere

Dr. Murry Salby
ATOC The University of Colorado IAMAS

We investigate systematic variations of dynamical structure that operate coherently with the 11-yr variation of UV irradiance. Only a small signature is visible at low frequency, where it reflects a simple linear response that drifts with solar flux, F_s. However, a signature of the solar cycle is prominent at high frequency, where coherent changes reflect a more complex nonlinear response. Such changes represent a decadal modulation of interannual fluctuations associated with the QBO. They are shown to have the salient structure of the residual mean circulation of the middle atmosphere, the so-called Brewer-Dobson circulation. Sampling the atmospheric record around solstice, when the residual circulation is active, and during extremal phases of the QBO sharply enhances the strength, significance, and hemispheric symmetry of the the solar signal. In the tropics, the correlation to solar activity has structure of the residual circulation of the QBO, which undergoes a modulation that tracks F_s. In power spectra, that modulation is manifested in two spectral peaks that straddle the QBO's mean frequency: one at 24 months, marking a Biennial Oscillation (BO), and another at 36 months. Intrinsic to the QBO, those side lobes are separated from the QBO's mean frequency by 11 yrs^-1. In running spectrum analysis, they undergo an 11-yr modulation. Accompanying the signal in the tropical stratosphere is a stronger signature over the winter pole. Discovered by Labitzke and van Loon (1988), the polar signature of the solar cycle reflects anomalous downwelling of the Brewer-Dobson circulation. It is comparable to the overall interannual variance. Representing a decadal modulation of interannual fluctuations, that signature of the solar cycle extends downward into the Arctic troposphere. Also varying coherently with stratospheric fluctuations are fluctuations inside the tropical troposphere, associated with the Hadley circulation. Like interannual fluctuations over the Arctic, they undergo a decadal modulation, one that bears the same relationship to the equatorial QBO as does the polar stratosphere.

Keywords: solar, cycle, circulation

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

JAS007 **Oral Presentation** **433**

Tropospheric response to the 20 November 2003 geomagnetic storm using global GPS network data

Dr. Shuanggen Jin
Astro-Geodynamics Center Shanghai Astronomical Observatory, Chinese Aca.Sci IAG

Jung-Ho Cho, Jong-Uk Park,

It is well known that geomagnetic storms severely affect the ionosphere, but maybe act at various altitudes in the atmosphere, even possibly including the lower layer and the troposphere. However, such possible effect on the troposphere is usually ignored due to lack of real observation evidence or mechanism explanation. In this paper, we use global continuous IGS GPS observation data to derived the zenith tropospheric delay (ZTD) and first investigate the ZTD behaviors during the larger geomagnetic storm on 20 November 2003 with a maximum Dst index of -472 nT. It has found that the ZTD has systematically increased before the geomagnetic storm and then degraded in most continental areas with up to 150 mm in the amplitude, indicating a great effect on the ZTD. In addition, the basic parameter (temperature) on the terrestrial surface is also further investigated during this larger geomagnetic storm. It has revealed the same phenomenon that the short- and long-term temperature time series on the surface have also the same systematic variations during the geomagnetic storm, again showing geomagnetic storm effect on the troposphere.

Keywords: geomagnetic storm, troposphere, gps

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

JAS007 **Oral Presentation** **434**

Observation of gravity waves oscillations in F2-layer heights at low latitude during high and low solar activity

Dr. Paulo Roberto Fagundes
Physicas and Astronomy UNIVAP IAGA

Virginia Klausner, Y. Sahai, Valdir Gil Pillat, Fabio Becker-Guedes

Ionospheric vertical sounding observations, using a digital ionosonde, are being carried out at Sao Jose dos Campos (23.2o S, 45.9o W; dip latitude 17.6oS), Brazil, under the southern crest of the equatorial ionization anomaly (EIA), since August 2000. In this paper, we present and discuss the seasonal variation of gravity wave (GW) oscillations in the Ionospheric F2-layer during high solar activity (HSA, September 2000 to August 2001) and low solar activity (LSA, January 2006 to December 2006). The gravity wave signature in the F2-layer can be seen when the virtual height daily variations for 6 fixed frequencies (3, 4, 5, 6, 7 and 8 MHz) show wave-like oscillations (crests and valleys) with time delays. The crests and valleys when seen in close frequencies present a phase difference (i.e. first it is observed at higher frequency then at lower frequency), showing a downward phase velocity. These wave like oscillations show amplitudes varying from about 20 to 100 km. Then, the gravity waves are classified according to the amplitude of oscillations induced in the virtual height (h'F) in three groups weak (less than 40 km), moderate (from 40 km to 60 km) and strong (larger than 60 km). The observations show that GWs dominate at F-layer heights during HSA than LSA and strong GWs are present only during HSA. Also, the F2-layer stratifications are observed during both HSA and LSA, but are 10 times more frequent during HSA. The present observations indicate strong relationship between stratification of F2-layer and presence of GWs.

Keywords: f layer, gravity waves, eqatorial ionization anomaly

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

JAS007 **Oral Presentation** **435**

Radar observations of equatorial electrojet irregularities at Jicamarca

Prof. David Hysell
Earth and Atmospheric Science Cornell University IAGA

J. Drexler, E. B. Shume, J. L. Chau, D. E. Scipion, M. Vlasov, R. Cuevas, C. Heinselman

Daytime equatorial electrojet plasma irregularities were investigated using five different radar diagnostics at Jicamarca including range-time-intensity (RTI) mapping, Faraday rotation, radar imaging, oblique scattering, and multiple-frequency scattering using the new AMISR prototype UHF radar. The Doppler shifts of type 1 echoes observed at VHF and UHF frequencies are compared and interpreted in light of a model of Farley Buneman waves based on kinetic ions and fluid electrons with thermal effects included. Data point to the existence of plasma density striations separated by 3--5 km and propagating slowly downward. The striations may be caused by neutral atmospheric turbulence, and a possible scenario for their formation is discussed.

Keywords: ionosphere, electrojet, irregularities

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

JAS007 **Oral Presentation** **436**

Solar variability and climate change

Prof. Ulrich Cubasch
Meteorolgisches Institut Freie Universitt Berlin

Thomas Spangehl, Semjon Schimanke

The aim of this study is to assess the role of the solar variability and stratosphere in the observed climate change on the decadal to centennial time scale. For this purpose a coupled global ocean-troposphere-stratosphere model (EGMAM) with 39 levels (horizontal resolution T30) has been developed from the ECHO-G model, which has only 19 levels and only a rudimentary representation of the stratosphere. The performance of both models has been compared for the present day climate, for the historic climate evolution since 1630, and for an idealized solar forcing representing the Schwalbe- and the Gleissberg-Cycle. A comprehensive comparison with observational data and other climate models shows that both models simulate a similar near surface climate under constant present day boundary conditions. However, the EGMAM model simulates a slightly warmer climate and less sea ice in the southern hemisphere, especially in late summer, than the ECHO-G version, and reveals a weaker meridional thermohaline circulation. In the upper troposphere and the lower stratosphere EGMAM has a smaller error than the ECHO-G model. An assessment of historical simulations shows, that both models simulate a similar temporal evolution of climate including the Late Maunder Minimum on the global scale. In the idealized 11-year solar forcing experiment (Schwalbe cycle) the ocean behaves like a linear diffusive medium, while for the Gleissberg Cycle the ocean transports the heating signal not only downwards, but also laterally. Of particular interest is the Western Pacific warm pool region in the tropics: First results indicate that both models react to the solar forcing with an ENSO-type pattern oscillation. Its phase, however, depends strongly on the representation of the stratosphere, indicating a strong coupling between ocean and stratosphere. The mechanisms of this coupling will be discussed.

Keywords: solarvariability, climate, climate modeling

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

JAS007 **Oral Presentation** **437**

Study of the ozone response to the rotational solar activity variations at the Tropics by wavelet application

Dr. Rolf Werner
Stara Zagora Solar-Terrestrial Influences Laboratory, BAS IAGA

Ivan Kostadinov

The ozone variability at time scales of the solar rotation period was studied using zonal averaged total ozone column (TOC) TOMS data. For a latitude sequence of time series Morlet wavelet spectra for periods from 20 up to 55 days were calculated. The wavelets were scale averaged over a period interval from 24 up to 34 days, which are typical for solar activity variations caused by the solar rotation. The correlation between the ozone and the solar variations was studied by cross-wavelet analysis. By the help of the scale averaged wavelet spectra, Hovmller (latitude - time) diagrams of the wavelet variance for TOC were constructed. It was shown, that for time period of some months the ozone variations had a 27- days period. This period was almost in phase with the rotational solar activity variations suggesting that the ozone variations at the tropic in these time intervals were solar generate.

Keywords: ozone variations, solar activity variations, wavelet analysis

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

JAS007 **Oral Presentation** **438**

The Effect of the Very Large Solar Proton Events of Solar Cycle 23 on the Middle Atmosphere

Dr. Charles Jackman
Laboratory for Atmospheres NASA Goddard Space Flight Center IAGA

Daniel R. Marsh, Francis M. Vitt, Rolando R. Garcia, Eric L. Fleming

The Whole Atmosphere Community Climate Model (WACCM) has been used to study the middle atmospheric (stratospheric and mesospheric) influences of solar proton events (SPEs). SPE-caused polar middle atmospheric effects have been measured by satellite instruments (e.g., UARS HALOE and Envisat MIPAS) and will be compared with the WACCM predictions. An especially active period of very large SPEs (e.g., July and November 2000, November 2001, and October/November 2003) occurred in the latest solar cycle and impacted the middle atmospheric polar cap regions. The SPE-caused ionization, as well as dissociation processes, led to the production of HOx (H, OH, HO2) and NOy (N, NO, NO2, NO3, HNO3, HO2NO2, N2O5, ClONO2, BrONO2). Substantial (>40%) short-lived mesospheric ozone decreases followed these enhancements of HOx and NOy and significant (>10%) stratospheric ozone changes continued for months beyond the very largest SPEs due to the long-lived NOy. The long-term SPE-caused polar ozone effects (both decreases and increases) after these very disturbed periods produced stratospheric temperature changes up to 2K.

Keywords: ozone, stratosphere mesosphere, solar proton event

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

JAS007 **Oral Presentation** **439**

Troposphere – ionosphere interaction at equatorial latitude, Tirunelveli, India

Dr. Manohar Lal Yadav
Equatorial Geophysical Research Laboratory Indian Institute of Geomagnetism IAGA

We have made an attempt to study the troposphere – ionosphere interaction at equatorial latitude station. The tropospheric variability has been studied by using surface pressure variation. The stratospheric variability has been studied by using ozone variability from the TOMS satellite. The mesopause temperature has been measured by Tiwari et al. (2002) and has been used in the present study. The magnetic activity index (aa-index) has been used as an input variability from the solar atmosphere. The gravity wave amplitude shows increasing trend from winter to summer season. The ozone column density shows decreasing trend from winter to summer of 2001. The tropospheric gravity wave amplitude found to be in similar phase to the mesopause temperature with a time lag of about 7 days. The aa-index shows some similarity with the tropospheric gravity wave amplitude at the time lag of about 15 days. The stratospheric – mesospheric – and thermospheric parameter shows the prominent presence of planetary waves of period 25 days, 14 days, 7 days etc. On the other hand, tropospheric power spectrum shows the presence of 27 days, 16 days, and 9 days etc. The tropospheric power spectral peak shows a time lag of two days with upper atmosphere power spectral peaks. This study shows that the disturbances takes about 15 days to reach from thermosphere to tropospheric altitude, and it takes about 7 days from the mesospheric to tropospheric altitude. Thus there might be a movement of disturbances from thermosphere to troposphere and the time lag is found to be varying from one to two week period.

Keywords: gravitywaves, ozone, ionosphere

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

JAS007 **Oral Presentation** **440**

New formula representations of high-latitude O+ ionospheric outflows for use in global magnetospheric modeling

Prof. James Horwitz
Department of Physics The University of Texas at Arlington IAGA

Wen Zeng

The magnetospheric community has shown increasing interest in obtaining compact representations of the ionospheric outflow fluxes and their relationships to putative drivers, notably for potential use in large-scale magnetospheric modeling efforts. Recent satellite data analyses by Strangeway et al.[2005] and Zheng et al.[2005] have obtained formula fits for the measurement-based relationships of the outflows levels to parameterizations for electron precipitation and Poynting fluxes, which are expected to be among the principal drivers, or closely related to them, for the ionospheric outflows. Here, we distill the results of an extensive set of systematic simulation runs with the UT Arlington Dynamic Fluid Kinetic (DyFK) code for ionospheric plasma field-aligned transport to obtain O+ outflow flux levels versus precipitation electron energy flux levels, characteristic energy levels of the precipitating electron, and the peak spectral wave densities for BBELF waves which transversely heat ionospheric ions, and other geophysical conditions. Spectrograms of the relationship of the ion outflow values to these electron energy flux and BBELF wave levels will be presented. We will also present approximate formula representations. Strangeway, R. J., R. E. Ergun, Y.-J. Su, C. W. Carlson, and R. C. Elphic, Factors controlling ionospheric outflows as observed at intermediate altitudes, J. Geophys. Res., 110, A03221, doi:10.1029/2004JA010829, 2005. Zheng, Y., T. E. Moore, F. S. Mozer, C. T. Russell, and R. J. Strangeway, Polar study of ionospheric ion outflow versus energy input, J. Geophys. Res., 110, A07210, doi:10.1029/2004JA010995, 2005.

Keywords: ionosphere, outflow, aurora

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

JAS007 **Oral Presentation** **441**

Simulations of the O+ trough region in the polar cap ionosphere-magnetosphere coupling region with the UT Arlington DyFK model

Prof. James Horwitz

Department of Physics The University of Texas at Arlington IAGA

Fajer Jaafari, Wen Zeng

Measurements of low-energy ions by the Thermal Ion Dynamics Experiment(TIDE) on the POLAR spacecraft near 5000 km altitude show that both normal and low O+ density (trough) regions occur within the polar cap. For this presentation, the UT Arlington Dynamic Fluid-Kinetic (DyFK) model is employed to simulate such O+ density profiles. We drive a time-varying high-latitude convection model and incorporate auroral processes of soft electron precipitation and wave-driven ion heating to treat the evolving high-latitude ionospheric plasma transport and associated parameter profiles for several convecting flux tubes in the high-latitude ionosphere-magnetosphere system. We incorporate estimated locations of the auroral processes regions from the Ovation auroral oval model, which has as inputs auroral precipitation measurements from DSMP. These flux tubes nominally intersected the POLAR trajectory where the density measurements were made, based on the convection model utilized. It is found that, owing chiefly to F-region recombination processes during trajectory segments when the low altitude portions of such flux tubes in darkness, as well as auroral fountain effects in the auroral region, normal and low trough-like densities at higher altitudes develop along these flux tubes. In this presentation, the simulated densities near 5000 km altitude will be compared with POLAR/TIDE-measured O+ densities for inside and outside of these observed trough regions.

Keywords: ionosphere, magnetosphere, trough

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

JAS007 **Oral Presentation** **442**

Observations of mesospheric gravity waves above Halley, Antarctica (76S, 27W) using an imaging riometer.

Dr. Tracy Moffat-Griffin

Martin J Jarvis, Robert E Hibbins

The Imaging Riometer for Ionospheric Studies (IRIS), based at Halley (76S 27W), responds to changes in the absorption of cosmic radio noise in the ionosphere at ~90km. The compression and rarefaction of the atmosphere caused by mesospheric gravity waves at this altitude is also detectable by IRIS. The mesospheric gravity waves have propagated up from the lower atmosphere to the mesopause region where they dissipate. Work in applying wavelet analysis techniques to the IRIS data has resulted in extraction of the temporal and spatial characteristics of mesospheric gravity waves above Halley. A climatology of the gravity wave characteristics above Halley is being developed using IRIS data from 1998 to 2003. Initial results and comparisons to existing gravity wave studies are discussed.

Keywords: wavelets, imaging riometer, mesospheric gravity waves

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

JAS007 **Oral Presentation** **443**

Study of the atmospheric processes influence on the ionization of the ionosphere F2-layer

Dr. Vladimir Kurkin
Physics of Atmospere, Ionosphere and Radio Propaga Institute of Solar-Terrestrial Physics
IAGA

Polekh Nelya M., Vergasova Galina V., Chernigovskaya Marina A., Mikhalev Alexander V.

On the basis of data received on the Magadan-Irkutsk and Norilsk-Irkutsk oblique sounding paths the significant excess of maximal observed frequencies above median values in the morning and daytime hours during September, 24-26 was noted. According to vertical sounding data the ionization increase was observed in Irkutsk, Magadan and Norilsk at the same time. The analyzed period is characterized by quiet geomagnetic conditions. The spectral analysis of an annual course of critical frequencies of Irkutsk station has shown fluctuations with 10-12 days the periods in September 2005. These periods are characteristic for planetary waves. Besides these days the increasing of the ratio of atomic oxygen density to molecular nitrogen density [O]/[N2] in the lower thermosphere received by the UV-spectrometer of spatial scanning GUVI (Global Ultraviolet Imager) aboard the satellite TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics) was fixed above territory of Eastern Siberia. Significant variations of vertical structures of temperature in a stratosphere-mesosphere by MLS (Microwave Limb Sounder) aboard the spacecraft EOS Aura also were found out. Variations of the average night values of the atmospheric airglow intensities of atomic oxygen 557.7 нм (airglow heights about 85-115 km) with the period in some days (~6 days), correlating in some intervals of time with a variation of temperature of an atmosphere at a mesopause level were marked. Thus, in the extensive spatial area of Eastern Siberia, within several days simultaneous change of some parameters of the atmosphere and ionosphere was marked. This variations can serve as the experimental evidence of planetary waves penetration up to ionosphere heights and their influence on distribution of electronic concentration. The work has been carried out under RFBR grant (No. 05-05-64634).

Keywords: atmosphere, ionosphere, coupling

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

JAS007 **Oral Presentation** **444**

The impact of winds and waves in the stratosphere on dynamics in the mesosphere and lower thermosphere

Dr. Anne Smith
Atmospheric chemistry division NCAR IAGA

Jiyao Xu

Much of the variability in the mesosphere/lower thermosphere (MLT) region is a result of upward propagation of disturbances from below. Gravity waves originate primarily in the troposphere while planetary waves and tides have sources in both the troposphere and stratosphere. Large-scale stratospheric dynamical motions influence or control all three types of waves. Several aspects of the influence of the stratosphere on MLT dynamics will be investigated with observations from the TIMED satellite and with a 3-dimensional mechanistic model. For example, the QBO in tropical stratospheric winds affects the amplitude of the tides in the mesosphere. Possible mechanisms include the influence of the QBO winds on gravity wave propagation and hence on tidal dissipation rates, the direct effect of the wind on tidal propagation, the QBO in ozone and its effect on tidal forcing, and the effect of the QBO on the wintertime quasi-stationary planetary waves which then could interact to affect the tides. Another interaction is the impact of quasi-stationary planetary waves in the stratosphere on gravity waves and tides.

Keywords: mesosphere, tides, qbo

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

JAS007 **Oral Presentation** **445**

Solar Induced variations of odd nitrogen: Multiple regression analysis of UARS HALOE data

Dr. Lon Hood
Lunar and Planetary Laboratory University of Arizona IAMAS

A linear multiple regression statistical model is applied to estimate the solar induced component of odd nitrogen variability in the stratosphere and lower mesosphere using UARS HALOE data for 1991-2003. Consistent with earlier studies, evidence is obtained for a decadal NOx variation at the highest available latitudes (50-70 degrees) that projects positively onto the solar cycle. This variation, which is most statistically significant in the Southern Hemisphere, also correlates positively with the auroral Ap index. It is therefore probably caused by downward transport during the polar night of thermospheric and mesospheric odd nitrogen. In addition, at low latitudes near and above the stratopause, evidence is obtained for an inverse solar cycle NOx variation. It is suggested that this low-latitude response may be caused primarily by increased photolysis of NO under solar maximum conditions. Throughout most of the rest of the stratosphere, no statistically significant response is obtained. This implies that decadal variations of NOx, regardless of their source, played a minor or negligible role in the solar cycle variation of stratospheric ozone at middle and low latitudes during the 1992-2003 period. Significant effects on ozone at higher latitudes are expected to occur, however, such that when the Ap index is high, ozone in the polar stratosphere should be reduced.

Keywords: odd nitrogen, ozone

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

JAS007 **Oral Presentation** **446**

Global Distribution and Inter-annual Variations of Mesospheric and Lower Thermospheric Neutral Wind Migrating Diurnal Tide

Dr. Qian Wu
High Altitude Observatory National Center for Atmospheric Research IAGA

T. L. Killeen, R. G. Roble, S. C. Solomon, D. A. Ortland, W. R. Skinner, R. Niciejewski

Using the TIMED Doppler interferometer (TIDI) mesospheric and lower thermospheric neutral wind data (2002 2005) and NCAR TIME-GCM 1.2 annual run results at the TIDI sampling points, we study the migrating diurnal tide global distribution, interannual, and seasonal variations in connection with the mean zonal wind interannual and seasonal variations. Strong quasi-biennial oscillation (QBO) effect on the diurnal tide was observed in the TIDI data and reproduced to a less degree in the TIME-GCM run. The migrating diurnal tide amplitude is larger during the eastward phase of the stratosphere QBO and weaker during the westward phase. Westward mesosphere mean zonal winds appeared during the eastward phase of the stratosphere QBO. The strongest QBO effect on both the migrating diurnal tide and mean zonal winds were observed during the northern spring equinox. We believe that is because both the stratosphere winds and diurnal tide amplitude reach their maximum magnitudes during northern spring equinox. The stratospheric QBO winds apply the maximum filtering effect on the gravity waves, which in turn strongly modulate the diurnal and mean zonal winds. The TIDI data also exhibit large inter-hemispheric asymmetry. While in most cases, westward mean zonal winds in the mesosphere are associated with the enhanced diurnal tide, but not also. The results seem to imply that mean zonal wind is not the only factor controlling the diurnal tide amplitude. The TIME-GCM 1.2 diurnal tide amplitudes are in general smaller than that observed by TIDI. Limited vertical spatial resolution for the TIME-CGM 1.2 is suggested as the cause. Future improvements are expected with higher spatial resolution in the model.

Keywords: tide, qbo, tidi

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

JAS007 **Oral Presentation** **447**

Influence of the meridional circulation on temperature and airglow emission rate in the upper mesosphere and lower thermosphere

Prof. Gordon Shepherd
CRESS York University IAGA

Young-Min Cho, Guiping Liu, Raymond Roble

It is well known that the meridional mesospheric circulation has a major influence on the temperature of the mesosphere and lower thermosphere (MLT). The scenario is as follows. During the winter, poleward flow combined with downwelling maintains a warm winter MLT, while during the summer the equatorward flow combined with upwelling produces the lowest temperatures anywhere on the planet. A similar argument applies to the transport of atomic oxygen. Downward flow during the winter is expected to bring down air with a higher mixing ratio of atomic oxygen, increasing the airglow emission rate, while during the summer the same argument leads to lower emission rates. Previous work by the authors has shown that this is true in general, but that the airglow emission rates at times depart from the temperatures. To address the fundamental question, temperatures and emission rates obtained with Spectral Airglow Temperature Imager (SATI) instruments located at Resolute Bay (74 N) and King George Island (62 S) are compared with TIME-GCM predictions having normal meridional circulation. These data are supplemented by global emission rate patterns obtained with the Wind Imaging Interferometer (WINDII) on the Upper Atmosphere Research Satellite (UARS). Both datasets show that the meridional circulation often does not reach as high as the mesopause. During a winter at Resolute Bay, SATI temperatures obtained from the OH emission near 87 km agree well with the TIME-GCM, but the observed temperatures from the O2 Atm. Band airglow near 94 km are colder than the model, indicating that radiative cooling does play a significant role with respect to that of the meridional circulation. Similar results are seen in the King George Island data. The expected global emission rate pattern, of high winters and low summers is seen with the WINDII instrument only at altitudes well below the mesopause, consistent with what is seen in measurements of ground-based temperatures. The conclusion is that the mesospheric meridional circulation does not dominate the temperature regime near the mesospause but that radiative processes play a significant role. These results and the model comparisons are described and discussed in this presentation.

Keywords: temperature, airglow, mesosphere

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

JAS007 **Oral Presentation** **448**

Observations of coupling of the ionosphere and thermosphere to the sun and lower atmosphere

Dr. Larry Paxton
Space AGU

Hyosub Kil, Yongliang Zhang, Joseph Comberiate, Bob Demajistre, Andy Christensen, Bob Meier

The Global Ultraviolet Imager (GUVI) on the NASA TIMED mission observes the ionosphere and thermosphere in the far ultraviolet (120 to 180 nm). TIMED was launched in December 2001. The GUVI instrument has obtained millions of profiles of the Earth's atmosphere and ionosphere. In this paper we present the results of our studies of the coupling of the upper atmosphere to the Sun and near-Earth space (including magnetospheric inputs) and the lower atmosphere. The observations we will discuss include dayside measurements of neutral composition and the topside ionosphere, the nightside F-region ionosphere and the auroral inputs. We find clear evidence for a wavenumber 4 perturbation in the ionosphere. In addition we see evidence of the perturbation of the upper atmosphere by changing solar inputs (from solar maximum to solar minimum). Even larger perturbations are occassioned by geomagnetic activity in which forcing from high latitudes alters the global circulation of the thermosphere and, consequently, the behavior of the ionosphere.

Keywords: ionosphere, thermosphere, varibaility

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

JAS007 **Oral Presentation** **449**

Planetary wave type oscillations (PWTO) seen in ionospheric TEC-maps

Mrs. Claudia Borries
Institute of Communications and Navigation DLR IAGA

Norbert Jakowski, Christoph Jacobi, Peter Hoffmann, Alexander Pogoreltsev

The coupling of the atmosphere-ionosphere system through planetary waves is a frequently discussed phenomenon. While the climatology of planetary waves in the lower and middle atmosphere is already well known, the impact of these waves to thermospheric/ionospheric processes above 100km still needs deeper investigation. This subject is addressed by analysing hourly maps of Total Electron Content (TEC) of the ionosphere, which are regularly produced by the DLR Neustrelitz. Because the highest electron density exists in the F2-layer, the TEC maps mainly represent the variability of the ionosphere between 200 and 400km altitude. The maps cover the northern hemisphere from 50N to the polar cap and the years 2002 to 2006. For the analyses the Hayashi algorithm is used providing a separation of waves on one circle of latitude by wavenumber and direction. With the help of this algorithm planetary wave type oscillations in TEC are obtained in the zonal mean and wavenumber one and two. Similar to the behaviour of middle atmosphere planetary waves, TEC disturbances with periods above 10days mainly occur in winter, while shorter periods (below 10days) can be found during the entire year.

Keywords: ionosphere, planetary waves, coupling

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

JAS007 **Oral Presentation** **450**

Equinox transition of the mesospheric temperature field revisited

Dr. Marianna Shepherd
Centre for Research in Earth and Space Science York University IAGA

Airglow emission and temperature observations by the Wind Imaging Interferometer (WINDII) on the Upper Atmosphere Research Satellite (UARS) and ground-based stations revealed a rapid 2-day rise in the nighttime emission rate in spring time followed by a subsequent decrease in the magnitude, which was termed the springtime transition. A rapid temperature enhancement was also revealed in the average annual temperature at 87 km height in observations from 1991 to 1998. Large amplitude perturbations in mesospheric Na-lidar and OH rotational temperatures at 87 km around autumnal equinox were also reported both at middle and high Northern latitudes. Analysis has shown that these perturbations cannot result solely from planetary wave penetration but also from changes in the gravity wave flux entering the mesosphere. The seasonal temperature variation of the middle and high latitude upper mesosphere/lower thermosphere region is determined by the global vertical/meridional circulation and a meridional circulation from the summer to the winter polar regions. The dynamical structure of the MLT region is also perturbed on a long-period time scale of days to approximately a month by planetary waves, but also by rapid wind field changes e.g. owing to stratospheric warmings. The effect of low latitude phenomena like the quasi-biannual oscillation has also been detected in the middle and high latitude MLT temperature field, with peaks at the equinoxes. All these temperature studies employed observations only at 87 km from the 1990s, when no major stratospheric warmings were observed in the Northern hemisphere. In this report the response of the MLT temperature field is examined during periods of major stratospheric warmings, from December 2003 to April 2006; employing ground-based rotational temperatures from OH and O2 airglow observations by the SATI (Spectral Airglow Temperature Imager) at 87 km and 95 km, respectively at middle (Delaware observatory, 43N) and high (Resolute Bay, 74N) latitudes, temperature data from the SABER/TIMED experiment and meteor radar wind and temperature observations.

Keywords: temperature, mesosphere, spring timetransition

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

JAS007 **Oral Presentation** **451**

Observation of barometric oscillations and its comparison with geomagnetic pulsations

Prof. Toshihiko Iyemori
Graduate School of Science Kyoto University IAGA

Mitsuru Matsumura, Yoshikazu Tanaka, Akinori Saito, Masahito Nose, Naoto Oshiman, Yoko Odagi, Hiroyuki Shinagawa

It has been found that big earthquake or volcanic eruptions cause lower atmospheric disturbances, which propagate to the ionosphere and generate geomagnetic pulsations through acoustic wave resonance between the Earth's surface and thermosphere (i.e., ionospheric dynamo by the vertical wind.) To confirm the generality of such phenomena, we report recent results of multi-point atmospheric pressure observation in Japan and comparison with geomagnetic observation. The resolution of barometer is about 0.01hPa, and the data sampling is every one second. We confirmed the known characteristics from previous micro-barometric observations that the local perturbations dominate in general and show diurnal variations, higher amplitude in disturbed weather conditions etc. From our observation, we found that the spectral peaks at the resonance frequencies around 4 minutes often appear under stormy weather and some of them also accompany spectral peaks around the resonance frequencies also in geomagnetic field data.

Keywords: micro barometer, geomagnetic pulsation, acoustic wave

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

JAS007 **Oral Presentation** **452**

Structure of the Polar Non-Migrating Semidiurnal Tide Observed from TIDI

Prof. Scott Palo
Aerospace Engineering Sciences University of Colorado IAGA

Hiroyuki Iimura, Qian Wu, Timothy L Killeen, Stan C Solomon

A large westward propagating wavenumber one (W1) semidiurnal tide has been clearly identified from observations at the South Pole. Analysis of these ground-based observations has shown this nonmigrating semidiurnal tide to have a distinct seasonal structure maximizing in the Austral summer months and disappearing during the winter months. Recent observations from the South Pole have also indicated a long vertical wavelength and a maximum near 90km in the meridional wind field. In addition to the W1 nonmigrating semidiurnal tide a stationary (S0) nonmigrating semidiurnal tide has been observed using a combination of radar observations located along the coast of Antarctic near 70S latitude. These results indicate a rich spectrum of nonmigrating semidiurnal tidal components present over the Antarctic. However with a limited network of ground-based observatories in Antarctic a comprehensive analysis of the spatial structure of the nonmigrating semidiurnal tides over Antarctic has not been possible. A similar problem also exists in the northern hemisphere but is exacerbated by the lack of observational sites poleward of 75N. In this paper we will present results showing the spatial structure, both vertical and latitudinal, of the nonmigrating semidiurnal tides from wavenumbers 0 to 4. These results, determined from the TIDI horizontal wind measurements on board the TIMED satellite, will be presented for both the Arctic and the Antarctic winter and summer seasons. A comparison between the TIDI measurements in the vicinity of the South Pole with the meteor radar currently operating at the South Pole show good agreement for the W1 nonmigrating semidiurnal tide. Our results show a dominant W1 component in both the zonal and meridional wind fields at high southern latitudes during summer, which increase in amplitude with increasing latitude, and a mix of W1 and S0 components at lower latitudes. During the winter months the W1 component is reduced significantly in comparison to the summer months. Comparatively, the results for the Arctic show a weaker W1 response in the summer months than is seen in the Antarctic with virtually no response in the zonal wind field. These results will be discussed in connection with possible generation mechanisms for the nonmigrating semidiurnal tides at high latitudes.

Keywords: semidiurnaltide, nonmigrating, polar

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

JAS007 **Oral Presentation** **453**

The enhanced circulation in the mesosphere and lower thermosphere region

Prof. Miguel Larsen
Dept of Physics Clemson University

Large winds are a regular feature of the mesosphere/lower thermosphere (MLT) region in the altitude range from 95 to 115 km. The general characteristics of the winds in that height range were first brought to light based on analysis of an extensive set of chemical release wind measurements made over a period of four decades, but other more recent measurements, notably high-resolution lidar measurements, show similar features and frequency distributions in the winds measured with those techniques. Measurements of the circulation in the MLT region are difficult to obtain, but there are a few data sets available that suggest that the enhanced winds have a broad horizontal extent, which further suggests that the neutral circulation in that part of the atmosphere is significantly enhanced, at least part of the time. The altitude range where the enhanced winds occur is a critical region for the coupling between the neutral and ionized components of the atmosphere. The electrodynamic processes are therefore strongly affected by the structure and strength of the neutral circulation. The talk will summarize recent observational results related to the enhanced neutral circulation in the MLT region and will discuss the implications of the existence of the enhanced winds.

Keywords: thermosphere, neutral winds, ionosphere

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

JAS007 **Oral Presentation** **454**

Spatial and temporal variations of Atomic Oxygen in the Mesosphere and Lower Thermosphere

Dr. Jeng-Hwa Yee
Space Appled Physics LaboratoryJohns Hopkins University IAGA

W. R. Skinner

Atomic oxygen, the primary product of O2 photolysis, is the dominant constituent of the earth's upper thermosphere because there is no fast bimolecular reaction path to recombine O atoms above the mesopause. Recombination occurs in the mesopause region by catalytic reactions involving odd hydrogen, with the OH radical as the principal catalyst. Because atomic oxygen is in chemical equilibrium only below 80 km, it is an important chemical tracer of transport above this altitude. Remote sensing of airglow emissions whose excitation mechanisms involve atomic oxygen can provide measurements of the atomic oxygen concentration at this important region. In this paper, we will present the result of our continuous study on the atomic oxygen spatial distribution between 85 and 110 km and its tidal, seasonal, and solar cycle variabilities based on airglow and compositional measurements taken by SABER/TIDI/TIMED (2002 to present) and HRDI/UARS (1994-2005).

Keywords: mesosphere lower thermosphere, atomic oxygen, spatial temporal variations

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

JAS007 **Oral Presentation** **455**

Statistical Study of Ionospheric Scintillation Associated with Hurricanes and Typhoons

Dr. Rebecca Bishop
Space Sciences Department The Aerospace Corporation IAGA

Paul Straus

Interest in coupling between atmospheric regions continues to increase. Gravity waves generated in the troposphere are often cited as a coupling mechanism between the low and upper altitude regions. However, few experiments demonstrating coupling between the troposphere and thermosphere/ionosphere exist. Intense, localized storms, such as hurricanes and tropical storms, provide an ideal opportunity to examine tropospheric/ionospheric coupling. This study utilizes GPS occultation (GPSRO) to investigate TEC levels and ionospheric scintillation near hurricanes and typhoons. GPSRO measurements from receivers on LEO satellites supply accurate global ionospheric and upper atmospheric monitoring. This study utilizes data from the CHAMP, PicoSat, and COSMIC satellites. Observations from more than 150 tropical storms over three years are used to determine the presence of ionospheric scintillation within 1500 km horizontal distance of the storms center. Results show significant scintillation or ionospheric disturbances are observed near the storms. Specifically, during Pacific typhoons in 2002-2003, scintillation was present over 70% of the time.

Keywords: ionosphere, coupling, scintillation

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

JAS007 **Oral Presentation** **456**

Inter-annual and long-term variations observed in the ITM system

Dr. Elsayed Talaat
Space Department The Johns Hopkins University Applied Physics Lab. IAGA

Jeng-Hwa Yee, Xun Zhu, James Russell Iii, Martin G Mlynczak, Larry Paxton, Andrew Christensen

The Ionosphere-Thermosphere-Mesosphere (ITM) region is highly variable and has a complex system of drivers including variable solar radiation, geomagnetic activity, and forcing from the lower atmosphere. Waves that originate in the troposphere grow in amplitude as they travel upwards into decreasing density at higher altitudes where they become the most prominent dynamical features of the ITM. Planetary and gravity waves modify the zonal mean temperature and winds through dissipation and momentum deposition. The effects of these waves on the ITM are expected to depend on the level of solar activity. For all types of waves, how high they penetrate into the thermosphere depends on the temperature, wind, and viscosity profiles. Current observations have shown signatures of both gravity waves and planetary waves in upper atmospheric measurements of winds, temperature, and ion density. The momentum deposition from upward propagating waves is thought to generate the quasi-biennial oscillation (QBO) and semiannual oscillation (SAO) in the zonal circulation of the stratosphere and mesosphere. These zonal wind oscillations, in turn, modulate the waves as they propagate upwards, including the migrating and nonmigrating tides. Understanding the behavior of the tides is not only crucial to characterizing mesopause variability but also transport in the region. Momentum deposition by the diurnal tide at low latitudes in the lower thermosphere produces indirect circulations that will transport neutral and ionized constituents both vertically and horizontally to higher latitudes. Recent global observations of the low latitude neutral atmospheric and ionospheric structure revealed by TIMED/SABER, TIMED/GUVI, TOPEX, and JASON allow us to investigate the interplay between the neutral, plasma, and background fields. Specifically, we will discuss inter-annual variability observed in mesosphere and lower thermosphere zonal mean temperatures and waves and examine the solar activity effects on the low-latitude ionosphere on different timescales including solar flare, rotational, and 11-year solar cycle effects and possible indicators of coupling between the lower and upper atmosphere.

Keywords: ionosphere, mesosphere, thermosphere

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

JAS007 **Oral Presentation** **457**

Mesospheric Production of Odd Hydrogen During the January 2005 Solar Proton Event

Dr. Pekka T. Verronen
Earth Observation Finnish Meteorological Institute IAGA

Annika Seppl, Erkki Kyrl, Johanna Tamminen, Herbert M. Pickett, Esa Turunen

Among the most striking phenomena affecting ozone in the middle atmosphere are solar proton events (SPE). During SPEs, precipitation of energetic particles into the polar atmosphere results in production of odd hydrogen (HOx) and odd nitrogen (NOx) species. Enhancements of HOx and NOx lead to depletion of ozone through the well-known catalytic reaction cycles. Although the effects of SPEs on atmospheric minor constituents have been studied since the 1960s, there has been lack of HOx observations. Thus, the theory of HOx production, involving quite complex hydrate ion chemistry, has not been validated by direct measurements. We utilize measurements from the MLS/Aura and GOMOS/Envisat instruments together with a coupled 1-D ion and neutral chemistry model to study the production of odd hydrogen and depletion of ozone in the mesosphere during the January 2005 solar proton event. The unique observational data allow us for the first time to directly test the HOx production theory. We point out that models using the so-called P(HOx/Q) parameterisation to include the effects of ion chemistry could underestimate the HOx production and the resulting ozone depletion in the mesosphere.

Keywords: solar proton event, odd hydrogen, ionosphere atmosphere

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

JAS007 **Oral Presentation** **458**

Resonant interaction between two planetary waves with zonal wave number 2

Mrs. Sabine Wuest
German Remote Sensing Data Center (DLR-DFD) German Aerospace Center (DLR)

Michael Bittner

Planetary waves have significant influence on atmospheric circulation since they explain several dynamical phenomena such as stratospheric warmings. These are attributed to breaking planetary waves and often result in the fact that the Arctic vortex is less severe than the Antarctic one.Nevertheless, the generation of stratospheric warmings is not totally clarified. The most promising explanation is the interaction of planetary waves: in many cases the amplitude of the quasi-stationary planetary wave 1 builds up due to resonant wave-wave interaction, for example, until it transmits its moment and energy to the background wind field. The role of wave 2 is usually considered to be less important. Based on ERA40-data (Jan. Feb. 1990) we found evidence that a wave-wave interaction of planetary waves no. 2 was responsible for a minor stratospheric warming in February 1990. At 70N harmonic analysis was used to determine the four dominant wavelengths along the circle of latitude.We saw a beat of the phase of the planetary wave no.2 and found out that it was possibly caused by two interacting planetary waves (wave number 2) with similar periodicities (about 3 to 4 days). Therefore, we tentatively interpret our results in the following way: a travelling wave 2 interacts with the stationary wave 2. This results in a quasi-stationary wave which shows a modulation very similar to the periodicity of the travelling one the above mentioned beat can be observed. Due to this resonant interaction, the quasi-stationary one builds up until it breaks down what results in a strong minor stratospheric warming. Additionally, energy seems to be transferred from wave 2 to wave 1.

Keywords: planetary waves, stratospheric warming, beat

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

JAS007 **Oral Presentation** **459**

Regions of low variability in the middle atmosphere

Dr. Michael Bittner

Sabine Wst

For the investigation of climate change it is important to distinguish between effects which are attributed to dynamical variability and a possible steady change of climate. In other words, it is necessary to determine regions of the atmosphere where daily dynamical processes are rather weak and the climatic background dominates. These regions are also interesting for the discrimination of chemical and dynamical processes or for satellite validation. In order to determine regions of low variability, so called quiet layers, temperature and ozone data are investigated. These data originate from ERA40-observations (investigated height interval: ~ 38km 65km) and the GOME-instrument (Global Ozone Monitoring Experiment) on the ERS2-satellite which measures the total column ozone. In order to get vertically resolved ozone data the GOME-measurements are assimilated into the 3D-ROSE-CTM (covered height interval: ~ 3 - 50km). The variability of the ERA40-temperature-data is calculated with regard to the zonal mean along the circles of latitude for different heights. The analysis shows horizontal as well as vertical regions of low variability. While the vertical ones can be attributed to the zero-crossing of planetary waves, the horizontal ones seem to be quiet layers proposed by Faust. Following his theory a meridional wind extremum is related to a vanishing zonal temperature gradient and vice versa. In order to check whether this relation is the explanation for our horizontal quite layers, a case study of meridional and zonal wind data from falling sphere experiments (covered height interval: ~ 33km 68km) which were flown during the DYANA-campaign in January and February 1990 at Andya (69N), Northern Norway is performed. Additionally, zonal and meridional temperature gradients between 70N and 60N using the above mentioned ERA40-data are calculated. The comparison of these analyses proves our hypothesis that the horizontal quiet layers can be attributed to Faust. A similar analysis is performed using the assimilated ozone data. Here, horizontal and vertical quiet layers can also be found.

Keywords: planetarywaves

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

JAS007 **Oral Presentation** **460**

Response of the mesosphere/lower thermosphere on severe solar proton events

Dr. Werner Singer
Radar Soundings Leibniz Institute of Atmospheric Physics IAGA

Peter Hoffmann, Ralph Latteck, Paulo P. Batista

Severe solar activity storms with related solar proton events (SPE) and X-ray flares (class X) influence the Earth ionosphere/atmosphere down to lower mesospheric altitudes. Changes of the dynamical and thermal state of the mesosphere/lower thermosphere around SPEs are studied using observations of meteor radars and MF radars in polar (69N), middle (54N), and low (22S) latitudes. Temperatures of the mesopause region are obtained from meteor decay times. Horizontal winds from MF radar and meteor radar observations cover the altitude range 55 to 98 km. Turbulent energy dissipation rates and electron densities are estimated with a narrow beam 3-MHz Doppler radar. The mesospheric response on seven solar activity storms with strongly enhanced proton fluxes at energies greater than 60 MeV in the period July 2000 until December 2006 has been studied in detail. During these solar proton events the neutral air temperature at mesopause heights is decreased by about 10 K to 30 K. At the same time a lowering of the peak altitude of the meteor layer by about 300 m to 700 m is observed. The decreased peak height results from the burn off of the meteoroids at lower heights due to reduced density. Particular attention is devoted to the solar proton events in October 2003 and January 2005 in respect to enhanced turbulence related with changes of the background wind field.

Keywords: solar proton event, mesosphere, temperature

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

JAS007 **Oral Presentation** **461**

Mechanism of formation of reactive-diffusional waves in the mesospheric photochemical system

Dr. Kulikov Mikhail
Atmospheric Physics and Microwave Diagnostics Institute of Applied Physics of the RAS

A.M. Feigin

It is well known, that the distributed chemical systems possessing nontrivial non-linear properties can demonstrate broad spectrum of reactive-diffusional waves such as traveling fronts, impulses, periodic waves, etc. These waves were found in the systems of difference nature: chemical, biological, geological, etc. The possibility of appearance of similar waves in the Earth atmosphere was discussed in the work [1]. In this report we consider the influence of horizontal (in a zonal direction) eddy diffusion on the mesospheric photochemical system, which includes all the most important photochemical reactions in the mesopause region (80-87 km). It is known (see, e.g., [2]), that this system can demonstrate photochemical oscillations of the minor gas constituents (H, OH, HO2, O and O3), playing key role in the mesosphere, with the time periods of 2, 3 and 4 days. These oscillations are subharmonical response of the mesospheric chemistry on the external periodic forcing (daily variations of Sun radiation). It was demonstrated numerically in the work [1] that horizontal eddy diffusion causes wave of the phase: phase of the oscillations enumerated above becomes to move in zonal direction with velocities whose magnitude is determined by horizontal eddy diffusion coefficient and length of the corresponding meridian, and depends on period of photochemical oscillations. Besides, the duration of oscillation period determines direction of the wave traveling. So, in the case 2 or 4-days oscillations both fronts and pulses travel only in western direction. In the case 3-day oscillations waves traveling both eastward, and westward, were found. In the present work we investigate nonlinear-dynamic mechanisms that lead to formation of these waves and demonstrate why the waves properties depend strongly on the period of photochemical oscillations. 1. M.Yu. Kulikov, A.M. Feigin. Reactive-diffusion waves in the mesospheric photochemical system. Advances in Space Research, v.35, n.11, p.1992-1998, 2005. 2. G. Sonnemann, A.M. Feigin, and Ya.I. Molkov. On the influence of diffusion upon the nonlinear behaviour of the photochemistry of the mesopause region. J. Geophys. Res., v.104, p.30591-30603, 1999.

Keywords: mesopause, photochemistry, forcing

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

JAS007 **Oral Presentation** **462**

Stratospheric Variability: Effects on Tropospheric Climate

Dr. Mark Baldwin
none ICMA IAGA

The paradigm of a separate stratosphere and troposphere is advantageous when describing quantities such as humidity, ozone, lapse rate, and potential vorticity. However, the continuous atmosphere allows vertical wave propagation, exchange of mass, and other interactions between these layers. In many respects the distiction between the stratosphere and troposphere is artificial. The dynamical coupling of the stratosphere and troposphere is primarily mediated by waves that propagate upwards, into the stratosphere, where they dissipate causing variability of the stratospheric flow. The conventional view is that of a one-way interaction in which tropospheric waves drive stratospheric variability. Recently, this view has given way to a more sophisticated understanding of a two-way interaction. Observations and model studies show that the stratosphere organizes chaotic wave forcing from below to create long-lived charges to the stratospheric circulation. These stratospheric changes can feed back to affect weather and climate in the troposphere. There are three primary areas in which stratosphere-troposphere coupling is important: 1) extended-range weather forecasts, 2) climate predictions, and 3) predictions of the evolution and recovery of the ozone layer. In this talk, I will provide an overview of stratosphere-troposphere coupling and discuss aspects of these three topics.

Keywords: stratosphere, climate, prediction

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

JAS007 **Oral Presentation** **463**

Mid and low latitude mesospheric temperature estimation using meteor radar and OH rotational temperatures

Prof. Iain Reid
Physics School of Chemistry & Physics IAGA

David A. Holdsworth, Jonathan Woithe, Daniel Mcintosh, Abas Sivjee4,, Ray J. Morris, Damian J. Murphy, Gary B. Burns, W. John R. French

This paper presents lower mid-latitude and Antarctic meteor radar temperature estimates derived from meteor diffusion coefficients using two techniques: pressure model and temperature gradient model. The temperatures are compared with a temperature model derived using colocated OH spectrometer measurements and Northern Hemisphere rocket observations. Pressure model temperatures derived using rocket derived pressures show good agreement with the temperature model, while those derived using Mass Spectrometer and Incoherent Scatter (MSIS) and CIRA model pressures show good agreement in winter but poor agreement in summer. This confirms previous studies suggesting the unreliability of high-latitude CIRA pressures. The temperature gradient model temperatures show good agreement with the temperature model but show larger fluctuations than the pressure model temperatures. Meteor temperature estimates made in Antarctica during the Southern delta-Aquarids meteor shower are shown to be biased, suggesting that care should be taken in applying meteor temperature estimation during meteor showers. On the basis of our results we recommend the use of the pressure model technique at all sites, subject to determination of an appropriate pressure model.

Keywords: antarctic meteor radar

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

JAS007 **Oral Presentation** **464**

Measurements and Models of spectral solar irradiance variations

Dr. Yvonne Unruh
Blackett Lab Imperial College London

S K Solanki, N Krivova

We give an introduction to the modelling of solar irradiance variations using a combination of solar disk images and empirical models of the solar active regions that are chiefly responsible for the changes in solar output. We present comparisons between modelled and observed solar variability on time scales ranging from days to decades. We also discuss the uncertainties and problems involved in estimating spectral variability on secular timescales.

Keywords: solar irradiance

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

JAS007 **Oral Presentation** **465**

Solar Irradiance Variability and its Effect on the Earth's Atmosphere

Dr. Judit Pap
Goddard Earth Sciences and Technology Center University of Maryland Baltimore County

Solar irradiance in the entire spectrum and at various UV and EUV wavelengths have been observed for three decades. These observations clearly demonstrated that solar irradiance varies on time scales of minutes to decades. Although the overall pattern of solar irradiance variations is similar at various wavelengths, being higher during high solar activity conditions, remarkable differences exist between the magnitude and shape of the observed changes. These differences result from the different physical conditions in the solar atmosphere where the irradiances are emitted. The total radiative output of the Sun establishes the Earth's radiative environment, and it is one of the major natural driving forces for the Earth's climate, therefore they may contribute to the long-term climate changes, especially in the pre-industrial era. Short-term irradiance variations over days, weeks, and a few years appear to have little direct effect on climate, however, the Earth's upper atmosphere is very responsive to solar activity variations through the effect of energetic radiations and particles. The study of the changes at various UV and EUV emissions is of primary interest, since they are implicated in a number of processes in the middle and upper atmosphere of the Earth, such as variations in ozone levels, the ionization of the E and F regions of the Earth's ionosphere and the thermospheric density, which is essential to determining the lifetime of Earth-orbiting satellites. In this paper we summarize the measurements and results of irradiance variations at various wavelengths and highlight their effect on various layers of the Earth's atmosphere.

Keywords: solar irradiance, uv euv emissions

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

JAS007 **Oral Presentation** **466**

The effects of solar variability on the coupling of gravity waves from the lower atmosphere with the thermosphere

Dr. Sharon Vadas
Colorado Research Assoc NorthWest Research Associates IAGA

D. C. Fritts

The lower atmosphere can couple with the thermosphere via the generation, propagation, and dissipation of large-vertical-wavelength gravity waves (GWs). Some of the GWs from the lower atmosphere, such as from deep convection in the troposphere, can propagate well into the thermosphere prior to dissipating. Using a new, complete, dissipative, anelastic GW dispersion relation, we find that the altitudes to which these GWs penetrate, and the magnitude and spatial characteristics of the dynamical effects which result in the thermosphere, depend sensitively on solar variability. During solar maximum, GWs propagate to much higher altitudes than during solar minimum prior to dissipation. Dissipative spectral filtering and increasing vertical wavelengths from increasing temperatures cause GW spectra from the lower atmosphere to increasingly shift to larger vertical wavelengths with altitude in the thermosphere. This shift along with the decreasing buoyancy frequency cause GW spectra to also shift to larger horizontal wavelengths with altitude. We describe how the dissipation of GWs in the thermosphere from convection creates intermittent and spatially-localized horizontal thermospheric body forces, which results in the generation of spatially-localized and intermittent thermospheric neutral winds and medium-scale secondary GWs/traveling ionospheric disturbances (TIDs) in the thermosphere. Because many GWs can penetrate to much higher altitudes during solar maximum than solar minimum, we find that the resulting thermospheric body force is spread out during solar maximum, which reduces its amplitude relative to that during solar minimum. This implies that generated neutral winds and medium-scale GW/TID amplitudes are likely larger during solar minimum than during solar maximum. We also show that some of the surviving GWs from convection may have the appropriate characteristics to seed plasma instabilities and equatorial spread-F during a wide range of solar conditions.

Keywords: thermosphere, gws

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

JAS007 **Poster presentation** **467**

To the external forcing of the MLT winds

Prof. Edward Kazimirovsky
Institute of Solar-Terrestrial Physics Russian Academy of Sciences IAGA

TO THE EXTERNAL FORCING OF THE MLT WINDS Edward Kazimirovsky, Galina Vergasova Institute of Solar-Terrestrial Physics, Russian Academy of Science,P/B 4026, 664033 Irkutsk, Russia We believe that the atmosphere is a single system with links between all levels. The horizontal winds in the mesosphere/lower thermosphere (MLT) over East Siberia were regularly measured by

Keywords: mlt winds, stratosphere warmings, geomagnetic storms

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

JAS007 **Poster presentation** **468**

On the connection between intensity of atmospheric electric field as measured at ground surface and ionospheric electric field in Central Antarctica

Dr. Ludmila Makarova
Geophysics Arctic and Antarctic Research Institute IAGA

Frank-Kamenetsky A.V, Morozov V.N., Shirochkov A.V.

In this report data of ground based measurements of atmospheric electric field and data of the vertical ionosonde at Vostok Station (Antarctica) were analyzed to study atmosphere/ ionosphere electrodynamic coupling, which could be influencing either from upper source (energy of the solar wind) or from below (atmospheric electricity). It was turned out that the specific ionospheric events directly connected with increase of electric fields in the polar ionosphere (slant sporadic E layer with retardation; FLIZ layer in F-region) were observed with close coincidence with significant increases of atmospheric electric field as measured by ground-based detector at the same station. As the rule increasing values of electric field in the ionosphere and atmosphere were connected with forcing by solar activity and by increasing energy of the solar wind. Influence of local generators of electrical charges produced by the meteorological processes in surface layer of atmosphere on value of electric field in the polar ionosphere is considered also. A numerical model of a height distribution of electric field from ground surface till ionosphere altitudes is presented. Cylindrical distribution of electrical charges in surface layer and exponential distribution of electrical conductivity with altitude are used in this model. The non-stationary and stationary approximations were solved. Magnitude of electric field defined these electrical charges has the following typical value for radial component in the polar ionosphere: (0.02-0.2)V/m for total charge in surface layer (1-10) C (Coulomb) for non-stationary approximation and (100-1000) C for stationary case. Calculated values of electric field strength are compared with values of the electrical field strength produced by the magnetospheric field-aligned currents in the polar ionosphere. Our conclusion is that the external source of magnitude of ionospheric electric fields exceeds significantly contribution to it from the ground surface source.

Keywords: atmosphericelectricity, ionosphericelectricfield, solaractivity

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

JAS007 **Poster presentation** **469**

The transionosphere propagation effects on solar flare VHF radio emission at spaced sites.

Prof. Yuri Ruzhin
IZMIRAN, Russian Academy Vice director

C. Nomicos, E. L. Afraimovich, I. N. Bershadskaya, G. Koulouras, V. V. Fomichev

Solar flare result in fast rise of the solar ionization fluxes (by tens times for a few minutes) at the Earths ionosphere. The ionosphere is modified during pulse of ionizing flare radiation in ultraviolet and X-ray ranges. The solar flare is one of possibility to illuminate the all stations of VHF net on the dayside simultaneously.The results of simultaneous observations of radio emission of X38 (17.01.2005) solar flare at four Greece stations in region of the Mediterranean sea and on 8 frequencies of a VHF band (41, 46, 142, 178, 230, 320, 390 and 415 MHz) are presented. The comparison of these data to the data received in IZMIRAN through a radio spectrograph (25-280 MHz) and on fixed frequencies 168, 204 and 3000 MHz are conducted. It is found the spatial heterogeneity of solar radio emission intensity detected by VHF network at distances less 100 km was caused by radio emission propagation through inhomogeneous and nonstationary ionosphere. By using the data of European network of GPS two-frequency receivers and Global Ionospheric Maps (GIM) of total electron content to check the ionosphere state it is shown, that such inhomogeneous structure or high variability of ionosphere (that usually is transparent for VHF band) is generated by solar UV and X-ray emissions during the flare.

Keywords: solar, flare, ionosphere

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

JAS007 **Poster presentation** **470**

Doppler observations of night-time sporadic e layer during sunrise in magnetic conjugated ionosphere

Prof. Yuri Ruzhin
IZMIRAN, Russian Academy Vice director

V.Yu. Kim, V.A.Panchenko, V.P. Polimatidi, I.N.Bershadskaya, I.I.Shagimuratov

Several papers have been written about the observed relationship between night ionosphere disturbances and conjugate point sunrise. In this paper we present the results of the experimental research of plasma motion and variations of night-time ionospheric Es layer by multifrequency Doppler sounding (and total electron content measurements) during the winter solstice. Doppler measurements in a mode of vertical sounding simultaneously on 4 frequencies were carried out by the IZMIRAN ionospheric facility "Bazis-M" (provided signals reflection from Es- and F- layers of an ionosphere). To have total electron content variations the data of GPS net are used. The data analysis has shown that in night-time (from 04 LT to 06 LT) the Es signal amplitude increase about 10 15 dB and it is proportional to increase in plasma electron density. Doppler measurements have shown the horizontal drifts (more than 10 m/sec) and upward movements of sporadic plasma clouds. The TEC measurements have indicated a complex behavior of night ionosphere during sunrise in the opposite hemisphere. Being combined these data definitely supports the hypothesis on partially reflected downcoming Alfvenic waves generated in magnetic conjugated ionosphere by supersonic terminator motion.

Keywords: sporadic e, solstice, terminator

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

JAS007 **Poster presentation** **471**

Plasma bubble phenomena in the topside ionosphere: high solar activity period

Dr. Larissa Sidorova
IZMIRAN Russian Academy of Science IAGA

The present study deals with the He+ density depletions (subtroughs), observed during a high solar activity. There are the indications that plasma bubbles, produced by Rayleigh-Taylor instability at the bottomside of ionosphere, could rise up to the topside ionosphere and plasmasphere. Maryama and Matuura (1984), using ISS-b satellite data (high solar activity period, 1978-79), have seen the plasma bubbles in Ne density over equator at 1100 km altitudes in 46 cases in 1700 passes. That is ~3% only. However, there is distinctly another picture in He+ density depletions (subtroughs) according to ISS-b data for the same period. He+ density subtroughs occur in the topside ionosphere over equatorial and low-latitudinal regions (L~1.3-3) in 11% of the cases (Karpachev, Sidorova, 2002; Sidorova, 2004). The detailed statistical study of the He+ density subtrough peculiarities was done. The subtrough depth (depletion value) as function of local time (evening–night hours) was compared with the vertical plasma drift velocity variations, obtained for the same periods from AE-E satellite and IS radar (Jicamarca) data. Striking similarity in development dynamics was revealed for the different seasons. It was noted also that the He+ density subtroughs are mostly observed in the evening-night sector (18-05 LT) from October till May. It was like to the peculiarities of the equatorial spread-F (ESF), usually associated with plasma bubble. The monthly mean He+ density subtrough occurrence probability, plotted in local time versus month, was compared with the similar plots for ESF occurrence probability, derived by Abdu and colleagues (2000) from ground-based ionograms obtained over Brazilian regions for the same years. The comparison shows good enough correlation (R=0.67). Moreover, it was revealed that there are many cases of the He+ density subtrough observations on the OGO-4 (1968 - solar maximum, 20th cycle), the OGO-6 (1969 - solar maximum, 20th cycle) and DE-2 (1981 - solar maximum, 21th cycle) data. It was concluded, that the He+ density depletions should be considered as originating from equatorial plasma bubbles phenomena, or as possible fossil bubble signatures. It was also concluded that the He+ density depletions are rather typical phenomena for the topside ionosphere for high solar activity epoch. The possible reasons of the He+ density depletions occurrence as function of solar activity are discussed. REFERENCE Maryama, T. and N. Matuura, Longitudinal Variability of Annual Changes in Activity of Equatorial Spread F and Plasma Bubbles, Journal of Geophysical Research, Vol.89, N A12, P.P. 10,903-10,912, December 1, 1984. Karpachev, A.T. and L.N. Sidorova, Occurrence probability of the light ion trough and subtrough in He+ density on season and local time, Adv. Space Res. 29, 999-1008, 2002. Sidorova, L.N., He+ density topside modeling based on ISS-b satellite data, Adv. Space Res., 33, 850-854, 2004. Abdu, M.A., J.H.A. Sobral, I.S. Batista, Equatorial spread F statistics in the american longitudes: some problems relevant to ESF description in the IRI scheme, Adv. Space Res., 25, 113-124, 2000.

Keywords: he+ density depletions, plasma bubble phenomena, solar activity

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

JAS007 **Poster presentation** **472**

Geomagnetic storm induced tropospheric wind and temperature variation over equatorial latitude

Dr. Manohar Lal Yadav

Equatorial Geophysical Research Laboratory Indian Institute of Geomagnetism IAGA

We have made an attempt to study the influence of geomagnetic storm on the equatorial upper troposphere temperature and wind variability. The NCEP – Re analysis data has been taken as an input for the present study. The Dst index has been taken as an indicator of the onset of magnetic storm. The changes in the temperature and wind variation is found to be sensitive to the local meteorological condition. The superpose epoch analysis shows the changes in temperature and wind velocity after 3 days of the onset of the event (i.e., geomagnetic storm). The influence of QBO phase has been found to be significant on the temperature as well as vertical wind velocity variation. The changes in the magnitude is also sensitive to the solar activity condition. The increase in the temperature during W-phase of QBO and vice versa has been observed after the onset of the event. The horizontal wind velocity shows the influence of magnetic storm on the continent as well as over the Ocean. The longitudinal variation of vertical wind velocity shows an increase over the Arabian Ocean and decrease in the velocity over the African continent. The longitudinal variation is found to be more effective during the E-phase of QBO.

Keywords: qbo, geomagneticstorm, meteorological

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

JAS007 **Poster presentation** **473**

Response of Ionospheric-Magnetospheric System to Solar Flare 04.11.2003

Dr. Andrei Moldavanov
R&D Tranzeo Wireless Technologies Inc. IAGA

Vladimir Parkhomov

This report deals with observations of near simultaneous oscillatory disturbances recorded in different points inside the magnetosphere and on the ground across all the latitude-longitudinal sectors during the solar flare 04.11.2003. There were no any other sources of ionospheric-magnetospheric perturbations at this time. Spectral composition of this flare is characterizing by existence of two separate (time lag ~ 45 min) maximums: first in X- ray range (average quantum energy < 100 keV) and second in gamma-ray range (average quantum energy > 100 keV). We observed very different ionospheric-magnetospheric response during X- and gamma phases of this flare. While the X-ray phase, we have seen the classic SFE-effect with low and mid latitudes ground manifestation and absence of any magnetospheric signatures. However, during the gamma-ray phase, we detected unusual ionospheric and pronounced magnetospheric response, which can not be adequately described by classical theory of a flare-terrestrial coupling implying ionization growing on E and D ionospheric layers and intensification of Sq-current system. According to records of ground-based magnetometers, during the gamma-ray phase, the ULF (1-103 mHz) geomagnetic field response represents superposition of traveling oscillatory trains and simultaneous global impulse and demonstrates synchronous world-wide appearance of amplitude-spectral characteristics, existence of two amplitude maximums in auroral latitudes and time delay of amplitude maximum in respect to maximum of gamma-ray flux ~ 10 min. Magnetospheric disturbances in a magnetic field (GOES spacecrafts) and fluxes of trapped radiation in the energy range 50-1500 keV (LANL spacecrafts) demonstrate identical spectral characteristics, near the simultaneous onset on different spacecrafts and close correlation with magnetic perturbations on ground observatories for conjugate cases. So, we presume that during this solar flare the same physical source is responsible for disturbances on the ground and in the magnetosphere. We believe that observing signatures represent response to changes in topology of ionospheric-magnetospheric system, which starts from absorption of hard flare radiation on subionospheric altitudes. In particular, oscillatory character of disturbances in radial component of electric and azimuthal component of magnetic field on discrete frequencies in the Pc5 band suggests an idea on field line resonances driven by the waveguide mode at global excitation of magnetosphere. Global magnetospheric response might be related to intensification of magnetotail drivers through atmosphere-magnetosphere energy link leading, in particular, to radial diffusion of charged particles in and out of trapped radiation zone, however actual nature of global magnetospheric response requires further study.

Keywords: flare, stratosphere, magnetosphere

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

JAS007 **Poster presentation** **474**

Response of global and regional ionosphere electron content to solar activity changes

Dr. Elvira Astafyeva
Department of Atmosphere and Ionosphere Physics Institute of Solar-Terrestrial Physics SB RAS IAGA

Edward L. Afraimovich, Ilya V. Zhivetiev, Yuri V. Yasukevich

Solar activity is known to be the main factor determining the state of the Earths ionosphere. Global electron content (GEC) is a new method to study the relation between solar activity and the ionosphere. GEC was suggested for the first time by Afraimovich et al. (Doklady, Earth Sciences, 2006, 409A, N6, 921-924) as the total number of electrons in the near space. As a result, we obtain an ionosphere parameter that reveals global changes of the ionosphere despite separate local features. Therefore, GEC shows the direct influence of solar activity better than any other ionosphere parameter. In our work we analyzed data for the period 1996-2006 years and we found that variability of solar activity shows up in GEC data series. The value of GEC changes follows variations of sunspot number and solar radiation intensity: Lyman-alpha irradiance at 121.67 nm, extreme ultra violet (EUV) radiation and solar radio emission at 10.7-cm wavelength, showing 11-year and 27-day periodicities. Good correlation between variations of GEC and EUV was found, whereas we observed saturation effect of GEC when F10.7 increases. This means, in particular, that use of index F10.7 in ionosphere modeling leads to an error in estimation of ionosphere parameters at high solar activity. Additional information about global circulation of the ionosphere plasma at different levels of solar activity can be obtained from estimation of regional electron content (REC) as the number of electrons over a territory under consideration. For the 23rd cycle of solar activity we investigated dynamics of REC in the equatorial anomaly area and middle-latitude regions for both Northern and Southern hemispheres (+/-30 and from 30 to 65 of geomagnetic latitude, respectively). The amplitude of REC annual variations for the mid-latitude regions is almost twice as much as the amplitude of seasonal variations. A ratio R(t) of the equatorial REC for the day and night sides of the Earth is twice as less as R(t) for GEC. It means that nighttime ionization in equatorial region is very high, especially during high solar activity. Since GEC and REC changes are caused not only by variations in the solar ionizing radiation but by processes in the thermosphere as well, it is necessary to model the whole complex of the atmosphere/ionosphere system. Thus, study of GEC and REC features and comparison of them with high time cadence solar data provide more information about the response of the atmosphere/ionosphere coupling system to changes of solar activity. GEC and REC data can be useful for investigation of the middle atmosphere and climate variability during the whole cycle of solar activity.

Keywords: gec, solar activity, rec

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

JAS007 **Poster presentation** **475**

The ionospheric effects of summer and winter convective storms as observed by Doppler shift measurements

Mrs. Tereza Sindelarova
Department of Aeronomy Intitute of Atmosphreic Physics, ASCR IAGA

Dalia Buresova, Jaroslav Chum

The tropospheric severe weather events count among important natural sources of infrasonic waves. They influence the ionosphere through upward propagating waves. Infrasonic waves can transport significant amount of energy to the upper atmosphere due to their upward focusing and the long term or continuous nature of the source. The Doppler shift measurements, started at Institute of Atmospheric Physics, Prague in 2004, allow us to observe ionospheric wave activity in the acoustic and gravity wave domain. We focus here on wave phenomena in the infrasonic range excited by convective storms activity. Convective storms are thought to emit infrasonic waves mainly through their mechanical motion; it means oscillations of cloud tops and the movement of storm cells. As most effective in producing infrasonic waves are regarded convective storms with cloud tops overreaching the tropopause. Here, we compare the impact on the ionosphere of convective storms in summer and in winter in order to study the importance of the height of cumulonimbus cloud tops. Due to the seasonal differences of the stratification/energetic potential of troposphere, the cumulonimbus clouds do not reach such extensive heights in winter as in summer. We selected several summertime convective storms typical for the monitored Central European region and a case of severe convective storm, which was accompanied by tornadoes and supercell development. The observed height of cumulonimbus clouds tops exceeded significantly the height of tropopause. We compared observed gravity and infrasonic wave activity at the ionospheric heights for summer and winter convective storms.

Keywords: ionosphere, thunderstorm, infrasound

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

JAS007 **Poster presentation** **476**

Variability of mesospheric tides due to latent heat release

Dr. Dennis Riggin
Colorado Research Associates Division NorthWest Research Associates IAGA

Ruth S. Lieberman, David A. Ortland, Nickolas J. Mitchell, James M. Russell Iii, Martin G. Mlynczak, Christopher J. Mertens

Tidal forcing due to latent heat release associated with intense tropical convection is quantified using monthly composited rainfall rate fields computed from Tropical Rainfall Measuring Mission (TRMM) data. The tidal forcing due to latent heat release is only about a third as strong as the forcing due to solar heating of water vapor. However, latent heat release is typically much more temporally and spatially variable. Diurnal and semidiurnal variability in the mesosphere are examined using temperature temperature data from the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) satellite instrument and mesospheric radar wind data. The effects of the zonal mean zonal winds on mesospheric tidal fields are diagnosed using a primitive equation tidal model. The model runs demonstrate that a global perspective of the tides is necessary because the background winds can focus the tidal Elliasen-Palm flux preferentially into the northern or southern hemisphere.

Keywords: tide, mesosphere, latent heat

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

JAS007 **Poster presentation** **477**

Comparison studies of OI 577.7 NM airglow and sporadic E layer characteristics variations observed over Irkutsk

Dr. Konstantin Ratovsky
Institute of Solar-Terrestrial Physics Russian Academy of Sciences IAGA

Mikhalev Alexander, Medvedev Andrey, Medvedeva Irina, Chernigovskaya Marina

The analysis of simultaneous observations of atomic oxygen 557.7 nm airglow and sporadic E (Es) layer characteristics over Irkutsk, Russia (52.5N, 104.3E) is presented in the report. Es data were obtained with the DPS-4 ionosonde located directly in Irkutsk. Airglow measurements were made in ISTP Geophysical observatory located 130 km southwest of Irkutsk; the 4 -channel zenith photometer and all-sky CCD imager were used. For the series of 5-7-day intervals the 557 nm emission intensity rise was accompanied by increase in occurrence of Es. On occasion we observed correlated diurnal variations of the airglow intensity and Es characteristics. The possible reasons of correlation between airglow intensity and electron density in the ionosphere E region are discussed in the report. In particular we analyzed atmospheric temperature height profiles measured by the Microwave Limb Sounder (MLS) aboard the EOS Aura spacecraft; we used the data from the NASA website http://acdisc.sci.gsfc.nasa.gov/Giovanni/mls/mls.mlsl2.2.shtml.

Keywords: airglow, sporadic e, correlation

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

JAS007 **Poster presentation** **478**

CPW-TEC: Climatology of planetary waves seen in ionospheric F-region perturbations using TEC of GPS

Mrs. Claudia Borries
Institute of Communications and Navigation DLR IAGA

Christoph Jacobi, Peter Hoffmann, Norbert Jakowski, Alexander Pogoreltsev

Regional TEC maps over the higher middle and polar latitudes that are regularly produced by DLR Neustrelitz are investigated with respect to planetary waves with zonal wavenumber 0-5 in the period range of several days. The results are compared with planetary wave analyses using stratospheric reanalyses and mesosphere/lower thermosphere radar wind and temperature data. Case studies show that planetary waves are simultaneously found in the middle atmosphere and ionosphere. Numerical modelling of the middle atmosphere using the COMMA-LIM circulation model is performed to analyse the possible penetration of PW effects into the thermosphere. The project aims at the construction of an upper atmosphere planetary wave climatology of PW in both hemispheres.

Keywords: ionosphere, planetary waves, climatology

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

JAS007 **Poster presentation** **479**

Investigations on the spatial characteristics of TIDs by the use of a broadband super-resolution direction finding system

Dr. Stefan Hawlitschka
Sensor Data Fusion FGAN-FKIE

In previous studies presented at IAGA the temporal characteristics of TIDs have been investigated by the use of a super-resolution direction finding system. HF radio stations were used to illuminate the ionosphere and the deviation of the estimated bearing from the true bearing had been used to long-term observe the distortion of the ionosphere introduced by ionospheric waves. Their occurrence had been tabled against time of day, K-index and reflecting layer of the HF waves. Now broadband observations of a complete radio band with a duration of 15 h comprising dozens of radio stations are available at our research establishment. The broadband monitoring system BRAHMS has been run as a single station locator. Due to the simultaneous observation of several radio stations with known but different locations the spatial propagation of TIDs have been investigated. By a combined analysis some spatial characteristics such as propagation direction, change of frequency, time delay of the arrival of the disturbance at different stations etc. will be shown in a first analysis. Examples for the propagation of the signatures of TIDs will be shown with the combined DF- observations into different directions. The propagation of the TIDs will be correlated to the geomagnetic conditions.

Keywords: ionosphere, tid, propagation

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

JAS007 **Poster presentation** **480**

On possible influence of the Earth's surface temperature on airglow variations

Dr. Alexander Mikhalev
Institute of Solar-Terrestrial Physics Russian Academy of Sciences IAGA

The peculiarity is analyzed of behaviour of interannual the OI 557.7 nm emission variations in the 23d solar cycle which implies breakdown of synchronous variations of the OI 557.7 nm emission and the solar activity. When comparing annual average of intensities of 557.7 nm emission with heliogeophysical and atmosphere parameters (F10.7, mesosphere temperature, total ozone content) high correlation with global anomalies of the Earth's surface temperature variations has been obtained. Similar effect of the influence of the Earth's surface temperature for the critical frequency of E layer of ionosphere at middle latitudes is indicated in [1]. As a possible explanation of obtained correlation of long-term variations of 557.7 nm emission and of the Earth's surface temperature, there is offered a mechanism based on the experimental fact of existence of quasi-stationary planetary structures at the airglow [2] and on the hypothesis of orography-thermal excitation of planetary waves [3]. According to this mechanism, change in contrast of average-annual temperatures in the continent-ocean system (or within continents) can determine changes in positions (or amplitudes) of maxima of quasi-stationary planetary structures and cause modulation of the airglow at upper atmosphere within fixed longitudinal zone. 1. Deminov M.G., Kolesnik A.G., Leschenko L.N., Sitnov Yu.S., Tsybikov V.V. //Geomagnetism and aeronomy. 2003. T. 43. N 3. P. 382388. 2. Wang D.Y., Ward W.E., Solheim B.H., Shepherd G.G. // Journal of Atmospheric and Solar-Terrestrial Physics. 2002. V. 64. P. 12731286. 3. Zhadin E.A. // Meteorology and hydrology. 2001. N 8. P. 2840.

Keywords: airglow, earth's surface temperature, solar cycle

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

JAS007 **Poster presentation** **481**

The Solar Proton Events and Atmospheric Aerosol above Yakutsk

Dr. Semyen Nikolashkin
Aeronomy Institute of Cosmophysical Researches and Aeronomy IAMAS

Galina Timofeeva, Semyen Titov, Yuri Nikolashkin

The results of investigation the reaction of the total depth of atmospheric aerosol on the Solar Proton Events (SPE) accompanied by sudden response on Dst-variations and Forbush-decreasing of the galactic cosmic rays intensities are presented. Were selected some events with SPE and a CIMEL CE318 sunphotometer observations near Yakutsk (~50 km to South of Yakutsk). The observation and data reduction methodic are presented on the site of the sunphotometers network AERONET (http://aeronet.gsfc.nasa.gov). Was considered the reaction of the total aerosol content in the atmosphere on wavelengths 340 and 1020 nm for reasons of the first wavelength corresponds to early stage aerosol clusters formation, and the second to the moment of water component formation, respectively. It is shown that some dependence of the atmospheric aerosol concentration on energetic protons (>1 MeV) flux reached Earth. 67 days after SPE is observed an atmospheric aerosol quantity increasing at first in small scale fraction, and in 12 days later in more large scale fraction which, how we suppose, is appear as condensed water drops.

Keywords: solar proton events, aerosol, atmosphere

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

JAS007 **Poster presentation** **482**

Solar diurnal tides in the horizontal winds between 90 and 110 km as observed by WINDII/UARS and simulated by CMAM

Prof. William Ward
Physics University of New Brunswick, Canada IAMAS

Ding Yi Wang, Jian Du, Aaron Power

The solar diurnal tides in the MLT (mesosphere and lower thermosphere) region of 90-110 km are explored by using the WINDII/UARS horizontal wind measurements taken during November 1991 through May 1997. The observational results are compared with the simulations of the extended Canadian Middle Atmosphere Model (CMAM). Both datasets show great similarities, but some significant differences are also found. The well-known westward propagating migrating tide with zonal wave number s=1 (W1) have the largest annual mean meridional amplitudes of 60 m/s around 20N and 20S and at 90 and 95 km levels, respectively, in the WINDII data, but at 93 and 102 km in the CMAM. The W1 meridional amplitudes show significant semi-annual variation with magnitudes of 15 m/s and northward maxima occurred around early March and late August. Our analysis also revealed the most prominent non-migrating diurnal tidal components in the MLT region: the eastward propagating diurnal tide with the wave number s=3 (E3), the standing diurnal oscillation with s=0 (D0), and the westward propagating diurnal tide with s=2 (W2). The strongest E3 mode occurs primarily around the equator at the altitudes between 95-110 km, with maximum annual mean zonal amplitude of 10-22 m/s for both WINDII and CMAM data. The E3 zonal amplitudes are dominated by annual variation, which has the largest magnitude of 12 m/s at altitudes between 95 and 110 km around the equator in the WINDII data, but of 6 m/s at 100 km near 20N and 20S in the CMAM data. The maximum eastward winds are seen around July/August in both hemispheres in the WINDII data, but around December/January in the CMAM. The D0 and W2 modes are more or less similar to the W1 mode. They have maximum annual mean meridional amplitudes of 16-20 m/s between 95-100 km at 20N and 20S, and show little annual/semi-annual variations, except for the W2 meridional amplitudes between 90-105 km at 20N, where the annual variation of 10 m/s exists. The combination of E3, D0, and W2 with W1 gives rise to significant longitude variations in the diurnal tide between 40 degrees latitude.

Keywords: tides, winds, satellite

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

JAS007 **Poster presentation** **483**

On consistence of field aligned coordinate system in space and corrected geomagnetic coordinated system on ground

Prof. Yonghua Liu
Upper Atmospheric Science Division Polar Research Institute of China IAGA

B. C. Zhang, R. Y. Liu, M. W. Dunlop

ULF wave are usually represented in goemagnetical Field Aligned coordinate System (FAS) in space and in Corrected GeoMagnetic (CGM) coordinate system on ground at high latitude. It is prerequisite to understand the relationship between the two kinds of coordinate systems when comparing the ULF waves behaviors and properties in space with what observed on ground. Simply mapping the FAS system to ground along the geomagnetical field lines shows that FAS system in space is consistent with the CGM system in Northern Hemisphere but out of phase on z and x(H) components in the southern Hemisphere. Imposing the 90 rotation (left hand here) of the wave ellipse when the waves penetrating through the ionosphere, we find that the z and y components in FAS agrees with z and H component in CGM but the x of FAS is out of phase with the D of CGM in Northern Hemisphere; the x, y and z components of FAS are out of phase respectively with the D, H and Z components of CGM in Southern Hemisphere. These will results in that the polarization of ULF waves seen in space will be consistent with that on ground in the Southern Hemisphere but opposite with that on ground in the Northern Hemisphere. Simultaneously observation of the Pc3 waves from the Cluster-II satellites and the ground station in the two Hemispheres confirmed this analysis.

Keywords: inconsistence, fas, cgm

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

JAS007 **Poster presentation** **484**

A planning magnetometer chain from Zhongshan station to dome-a base

Prof. Yonghua Liu
Upper Atmospheric Science Division Polar Research Institute of China IAGA

Zhang Bei-Chen, Yang Hui-Gen, Hu Hong-Qiao, Liu Rui-Yuan

A magnetometer chain from Zhongshan Station (76.38E, 69.37S in GEO) to Dome-A (77.54E, 80.37S) base in eastern Antarctica is under planning that will consist in five magnetometers. Where, one magnetometer has already been running successfully at Zhongshan station, and one will be deployed near Dome-A, the highest peak in term of sea level in Antarctica. The other three will be set along the route from Zhsongshan to Dome-A site by about every 300km. Due to the hash meteorological condition in Antarctica, the four magnetometers in inland of Antactica will take use of unmanned pattern ones. The magnetometer chain near Zhongshan could make a cross network together with the conjugated sites of the eastern Greenland magnetometer Chain, which is specially favourable to study the conjugated ULF phenomena, traveling current vortex, open/closed field line boundary, etc. The accomplishment of this project will greatly enhance the capability of monitoring geospace environment based on Zhongshan sation, and also make a contribution to the Plan of International Polar Year 20072008.

Keywords: magnetometer chain, zhongshan, dome a

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

JAS007 **Poster presentation** **485**

Analysis of Sq Current Structures Obtained from Ground-based Magnetic Field Observations

Mrs. Hiroko Kohta
Department of Earth and Planetary Sciences Graduate School of Sciences, Kyushu University
IAGA

Akimasa Yoshikawa, Teiji Uozumi, Kiyohumi Yumoto, Magdas/cpmn Group

To clarify relationship between the global Sq current system, the equatorial electrojet and interhemispheric field aligned currents in daytime, we have examined seasonal and day-to-day variations of Sq current structures in both hemispheres. We use global ground-based magnetic dataset obtained from the Circum-pan Pacific Magnetometer Network(CPMN) stations on quiet days over past 10 years(1996-2006). We have obtained following features about latitudinal and local time distributions of Sq current focuses: (1) The latitude of the Sq Current Center(SqCC) in the southern hemisphere is about 10 degrees higher than that in the northern hemisphere all year. It corresponds to difference between geographic and geomagnetic latitudes around the 210-degree magnetic meridian. (2) The SqCCs in the northern hemisphere and the southern hemisphere shift to relatively earlier and later local time in around April, respectively. While the SqCCs shift vice versa in around October. This result may come from the magnetic field effect by the field aligned current flowing from the center of Sq current vortex in the winter hemisphere to that in the summer hemisphere(Takeda, 1990). These observational results suggest a possibility that neutral wind structures and interhemispheric field aligned current system can be monitored by ground-based magnetic observations. In the present paper, we will also discuss seasonal and day-to-day variations of Sq current structures, and connections among Sq currents reproduced by ground-based magnetic data, the field aligned current and the neutral wind.

Keywords: sq

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

JAS007 **Poster presentation** **486**

Variability of Sporadic E layer over midlatitude station Pruhonice

Dr. Petra Sauli
Department of Aeronomy Institute of Atmospheric Physics ASCR IAGA

Alain Bourdillon, Daniel Kouba, Josef Boska

Sporadic E layer is subject of large scientific investigation. It is know that wave processes involving gravity waves, tides and planetary waves play important role in the layer formation. In the contribution we investigate variability of Sporadic E layer in midlatitude during period of low solar activity during summer. Two high sampling rate campaigns were performed in Pruhonice Observatory (50N, 14.6E). Using DPS 4 equipment two types of the data, ionograms and plasma drift, were recorded and further analysed. Our data sets consist of time series of critical frequencies foEs, corresponding maxima hEs and particle drifts at two frequencies in the height range 90 km 150 km. The quality of the data is very high since DPS4 measurement allows us to precisely determine parameters of the reflected in the receiver. Dominant oscillation modes, their persistence and prevailing plasma motion are discussed.

Keywords: es layer, variability, ionosphere

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

JAS007 **Poster presentation** **487**

Global ionosphere/thermosphere response to the March 22-23, 1979, storm

Dr. Alexander Karpachev
Solar Terrestrial Physics IZMIRAN IAGA

The global response of the ionosphere/thermosphere to the strong magnetospheric storm on March 22-23, 1979 is investigated. Data of the Cosmos-900 and Intercosmos-19 satellites and ground-based sounding, as well as the results of previous investigations, have been used. The global background distributions of Ne and Te from the Cosmos-900 data at heights of 420-450 km were constructed. The main features of the ionospheric response were found and investigated. The pattern of the global response of the ionosphere includes the variations in the ionospheric structure (the dayside cusp, nighttime auroral oval, ionospheric troughs, and equatorial anomaly) and the related variations in hmF2, NmF2, Ne, and Te in the ionosphere. The dynamics of the auroral and subauroral ionosphere has been studied based on simultaneous observations on the Cosmos-900 and Intercosmos-19 satellites. Variations in the positions of the equatorial boundaries of the dayside cusp and the nighttime auroral oval, auroral electrojet, minimum of the main ionospheric trough (MIT) and ring ionospheric trough (RIT), as well as of the related Te peaks, have been studied in detail. The dependence of the ionosphere/thermosphere response on local time at different latitudes has been distinguished. The negative and positive phases of the ionospheric strorm were thoroughly examined. The planetary effects of internal gravity waves, IGWs, have been investigated in detail. It has been established that the IGW effects in the ionosphere in terms of both universal and local time was determined by the pattern of high-latitude thermosphere heating, and that the wave front of the strong IGW covered practically all local times, i.e., all longitudes. One of the sources of the IGW was the thermospheric heating in the dayside cusp region. The IGW effects were clearly separated from the electric field effects related to the turnings of IMF BZ. The equatorial ionosphere variations are investigated. The equatorial anomaly both in the night-time and day-time during the main and recovery phases of the storm was depressed: its crests were decreased and shifted to the equator, and Ne and Te over the magnetic equator were increased. The development and depression of the equatorial anomaly is associated with the effects of the electric field both of the magnetospheric and ionospheric origin.

Keywords: magnetic storm, ionospheric response, thermospheric response

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

JAS007 **Poster presentation** **488**

Basic characteristics of E-region plasma motion over Pruhonice observatory

Mr. Daniel Kouba
Department of Aeronomy Institute of Atmospheric Physics, Prague IAGA

Sauli Petra, Boska Josef, Santolik Ondrej

Regular measurement of plasma motion brings new important information about the state of the ionosphere. We present here analysis of ionospheric plasma motion in the E region ionosphere during period of low solar activity. In the study we concentrate on the plasma motion at height range 90 km 150 km that corresponds to E-region. Data were collected during year 2006, period of exceptionally low geomagnetic and solar activity, which allows us to study plasma drifts in the quiet ionosphere. Our study involves measurements of DPS4 from ionospheric station Pruhonice (50N, 14.6E). Raw data are manually checked and controlled using method described in Kouba et al. (2007) consisting of robust reflection height range selection, setting limits on the Doppler frequency shift, and restriction of the echo arrival angle. Our preliminary results show how E-region drift evolves during the year 2006. In detail, we examine features of plasma motion: three velocity-components diurnal variability during quiet geomagnetic conditions and seasonal trends of daily characteristics. Our study represents enlargement of our approach to the E region ionosphere, where plasma motion is not regularly monitored.

Keywords: digisonde, e region drift, ionospheric plasma motion

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

JAS007 **Poster presentation** **489**

The Terdiurnal Tide Simulated by the Extended Canadian Middle Atmospheric Model (CMAM)

Mrs. Jian Du
Physics Department University of New Brunswick, Canada

The diurnal (24-hour) tide, which is dominated in the subtropics, and the semidiurnal (12-hour) tide, which is larger at high latitudes, have been extensively studied from the observations and models. However, our understanding of the terdiurnal (8-hour) tide remains limited, partly because of it being the third harmonic in the wind decomposition. Horizotal winds simulated from the extended Canadian Middle Atmosphere Model (CMAM) are analyzed to delineate diurnal, semidiurnal and terdiurnal tidal structures and stationary planetary waves. Each frequency component is then subjected to Fast Fourier Transform (FFT) to perform the zonal wavenumber decomposition for s = -5 to s = 5. In this paper, the seasonal-latitudinal and height structures of these 11 terdiurnal tide components are now revealed. The migrating terdiurnal component is dominated over other components at middle latitudes with significant amplitudes (wind speed over 15 m/s) in the lower thermosphere (90 -110 km). Theamplitudes vary strongly with season below 95 km and are maximum during winter; however above 95 km, the seasonal variation is not as obvious. Other components tend to peak at polar regions with amplitudes between 2 - 6 m/s. There is uncertainty about the origin of the terdiurnal tides. Solar heating, convective heating and latent heat release in the model at March and June for terdiurnal tidal components are utilized to aid in interpreting their behaviors and ascertaining their origins.

Keywords: terdiurnaltide, extended cmam

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

JAS007 **Poster presentation** **490**

Effects of geomagnetic activity on the E and F region ionospheric drifts during 2004 2007 years.

Dr. Josef Boska
Aeronomy Inst. of Atm.phys.

Three years of operation of the digisonde DPS 4 equipment, which started at midlatitude ionospheric observatory Pruhonice in January 2004, make possible to measure ionospheric drifts at two different ionospheric regions. The paper deals with effects of high solar and geomagnetic activity, which were observed at Průhonice observatory in ionospheric drifts measurements during 2004 2007 year in both (E and F).Significant changes of the ionospheric drifts were observed during several periods of a suddenly enhanced solar and geomagnetic activity.In standard autodrifts measurements with DPS 4, the velocity of F region drifts is usually determined near peak of electron concentration profile.From 2005 we measure at Průhonice ionospheric drifts at the height interval 90 150 km also. In this paper we report the results of measurements of the drifts velocities in E and F regions during disturbed conditions at midlatitude station Pruhonice.

Keywords: ionosphere, drift, digisonde

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

JAS007 **Poster presentation** **491**

The CAWSES Global Observing Campaign on Tides: initial results

Prof. William Ward
Physics University of New Brunswick, Canada IAMAS

M. Gerding, L. Goncharenko, P. Keckhut, D. Marsh, J. Oberheide, D.N. Rao, J. Scheer, W. Singer, J. Forbes, N. Grieger, S. Gurubaran, M. Hagan, K. Hamilton, R. Lieberman, M. Mlynczak, T. Nakamura, D. Pancheva, H. Takahashi

To unambiguously resolve the tidal components present in the Earth's atmosphere requires spatial and temporal sampling sufficient to resolve wavenumbers up to at least 5 and periods down to 4.8 hours every two to three days. Neither satellite or ground based observations on their own are capable of achieving these goals. Interpretation of tidal signatures in different observables (for example wind and temperature) is complicated by the fact the the associated latitudinal structures are typically different. The CAWSES Global Tidal Campaign was initiated to encourage collaboration between satellite and ground based observations and to identify features in various observation types consistent with specific components. This project is one of several sponsored under Theme 3, Atmospheric Coupling Processes, of the international Climate and Weather of the Sun Earth System program (CAWSES, a SCOSTEP sponsored program). The overall goal of the campaign is to provide global data sets for several concentrated time periods over the next few years which includes coordinated ground-based and satellite measurements and modeling efforts. Three campaign periods have been identified to date. The first tidal campaign took place from September 1 to October 31, 2005 to coincide with the "World Month" campaign undertaken by the Incoherent Scatter Radar community. This year two campaigns, March 1 to April 31, and June 1 to August 15 have been scheduled. These campaigns will allow the characterization of the heating sources, tidal components (migrating and nonmigrating), and tidal effects from the surface of the Earth to the ionosphere, and support and stimulate the use of models to simulate the conditions during these campaigns. Radar, microwave, optical, and ionospheric observations and satellite data are essential to the success of these campaigns and are now starting to be analysed. In this paper, we describe the organization of this effort, plans for the incorporation of various observation types, and early results from the campaigns.

Keywords: tides, cawses, global

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

JAS007 **Poster presentation** **492**

Determination of energy dissipation rate of neutral turbulence from sporadic-e thickness

Dr. Yurij Kyzyurov
Space Plasma Physics Main Astronomical Observatory NASU IAGA

Turbulence that plays a very significant role in the dynamics of atmospheric layers below the ionosphere is important for the ionospheric D and E regions too. Above an altitude of 80 km a source of the turbulence may be destruction of the atmospheric gravity waves and tides propagating from the lower atmospheric layers and also the nonlinear interaction of planetary waves and tides. These large-scale atmospheric motions are responsible for a vertical shear of the neutral wind that is necessary for the production of mid-latitude-type sporadic-E (such layers are also observed at auroral latitudes and even near the magnetic equator). The sporadic-E is an important example of the ionosphere-atmosphere interaction. Below the homopause level, the neutral turbulence exerts an essential influence on sporadic-E parameters and generates a fine structure of the layer. Intensification of the turbulence leads to reduction of the peak amplitude of the layer and to the increase in the sporadic-E thickness. Thus, from the sporadic-E parameters one may derive parameters of the turbulence. The mean rate of turbulent energy dissipation is a basic parameter of turbulence. Determination of the rate from sporadic-E parameters is the report aim. The known formula for the thickness of layer, Ls, is used to obtain an expression that connects the dissipation rate with sporadic-E parameters. The formula of Ls has been derived in the framework of macroscopic description of ionospheric plasma under the assumption of sporadic-E formation by a neutral wind with a sinusoidal vertical profile with amplitude velocity u0 and wavelength L0. An expression for the rate of turbulent energy dissipation is obtained with the use of the RichardsonObukhov law for turbulent diffusion. The obtained expression has allowed us to determine the dissipation rate when the sporadic-E was near 100 km altitude of mid-latitude ionosphere (the magnetic dip angle of 30 degrees), u0 =80 m/s, L0=7 km, for two variants of the sporadic-E ion composition (the mean ion mass took values 31 and 51 a.u.m.), and the thickness Ls was changed form 1 to 3 km. It was shown that in the first case of ion composition the dissipation rate changed from 32.9 to 295.7 mW/kg, and for the second from 7.3 to 66.4 mW/kg. For the sporadic-E above the homopause under the chosen set of parameters, its thickness Ls has to be about 115.3 m. Thus, even weak turbulence exerts an essential effect on the sporadic-E, and the sporadic-E thickness may be used for determination of the turbulent energy dissipation rate.

Keywords: turbulence, ionosphere, atmosphere

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

JAS008 **493 - 517**

Symposium
Long-term trends and changes in the atmosphere-ionosphere system

Convener : Dr. Gufran Beig
Co-Convener : Dr. Jan Lastovicka

Monitoring long-term trends mixed with short-term instabilities and periodicities in the Earth system have always been a challenge but the past two decades have enriched us with variety of observational data from space, airborne and ground-based platforms. The primary goal of this symposium is to discuss the most updated experimental and model results on long-term changes and trends in the stratosphere, mesosphere, thermosphere and ionosphere. The symposium will emphasize the emerging trend signals under global change and future predictions. To specify in more detail the relative importance of long-term natural and anthropogenic influences (greenhouse gas induces) on the observed trends is one of objectives of the symposium. Both observational and modeling/simulation papers are welcome

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

JAS008 **Oral Presentation** **493**

Solar Influence on the Composition and Climatology of the Mesosphere and Lower Thermosphere

Dr. Gufran Beig
P.M.&A. DIVISION INDIAN INSTITUTE OF TROPICAL METEOROLOGY IAGA

It was increasingly believed that until the solar-related changes in the long term temperature series are well understood and quantified in the mesosphere, there is little hope of separating out changes due to longer-term secular variability caused due to human induced changes at the surface, much less gaining any insight into their causes. Present investigations have revealed the presence of a solar component in mesospheric and thermospheric (MT) temperature in several data sets but not as strong as thought earlier and in some cases no significant solar signal is found. However, now the major challenge is in the interpretation of the various reported results which are diverse and even indicates latitudinal variability. This talk briefly reviews an up-to-date status of solar response in temperature structure of the MLT region and long term changes in composition and thermal structure of the mesosphere arising due to the forcing from below (human induced).

Keywords: mesosphere, temperature, solar

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

JAS008 **Oral Presentation** **494**

Progress and problems in the global change pattern in the upper atmosphere and ionosphere

Dr. Jan Lastovicka
Department of Aeronomy Institute of Atmospheric Physics, ASCR IAGA

Lastovicka et al. (Science, 2006; Ann. Geophysicae, 2007) created the first global pattern of the observed long-term change in the upper atmosphere and ionosphere, based on trend studies of various parameters. This global pattern is qualitative, there are still several gaps and a few discrepancies in long-term trend results, but the overall pattern of the observed long-term changes throughout the upper atmosphere is mutually consistent and qualitatively consistent with model predictions of the effect of increasing greenhouse gas concentration in the atmosphere. The upper atmosphere as a whole is cooling and contracting, and changes in temperature and related changes in minor constituents are responsible for changes of the ionosphere. Here I report progress in development of the global change pattern in the upper atmosphere and ionosphere, and particularly discuss open problems and the way how to deal with them.

Keywords: trends, ionosphere, atmosphere

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

JAS008 **Oral Presentation** **495**

Long-term Variabilities in the Mesosphere and Lower Thermosphere (MLT) Winds over Tirunelveli (8.7N, 77.8E)

Dr. Sundararajan Sridharan
Department of Space National Atmospheric Research Laboratory, Gadanki IAGA

Subramanian Gurubaran

The horizontal wind data acquired by MF radar at Tirunelveli (8.7N, 77.8E) for the years 1993-2006 are used to study the long-term variabilities in the mesosphere and lower thermosphere (MLT) winds. The zonal wind shows dominant semi-annual oscillation with westward winds during equinox months and eastward winds during solstice months. The firstward westward phase, which occurs during spring equinox undergoes interannual variability with larger westward winds during the years 1993, 1995 and 1997. This interannual variability has been interpreted as biennial oscillation (BO) in the MLT winds. However, this BO is absent in the year 1999, as the large westward winds, which is expected to occur during the year 1999, instead appear during the year 2000. Hence the period of BO is extended from nearly two years to three years. A comparison with stratospheric QBO suggests that the large westward MLT winds occur during when eastward winds occur at all levels in the lower stratosphere. It is observed that the period of stratospheric QBO winds is also extended to three years during when mesospheric BO period is extended to three years. Besides SAO and QBO, the zonal winds undergo intraseasonal oscillation (ISO), however with smaller amplitudes. It is well known that tropospheric parameters undergo intraseasonal variability with a period range 30-70-days, which has been termed as Madden-Julian oscillation. As the power spectrum of MLT zonal winds show similar periodicities in the range 30-70 days, it suggests that there could be a possible relation between the two oscillations observed at two different height regions. However, the direct upward propagation of ISO to MLT heights is not possible, as they have very slow phase speeds. It is generally believed that the intraseasonal cycles in the tropical tropospheric convection produce intraseasonal variations in the intensity of gravity waves and non-migrating tides impinging upon the mesosphere. These IS modulated wave activity induces similar periodicities in the wave induced driving of the zonal MLT flow. The present study aims to test this hypothesis using long-term outgoing longwave radiation (OLR) data, which have been used as a proxy for tropical convection. The long-term observations of meridional winds show that they undergo annual oscillation, which also shows enhancements in some years, when large westward winds are observed in zonal winds. Besides, there is is a decreasing tendency in annual mean meridional winds. These observations are under a detailed investigation based on the long-term variability of gravity waves and tides and the results obtained will be presented during the meeting.

Keywords: trend, tropical convection, sao

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

JAS008 **Oral Presentation** **496**

TIMED/GUVI remote sensing observations of thermospheric composition, temperature, and mass density from 2002-2007

Prof. Robert R Meier
Physics and Astronomy George Mason University IAGA

J. M. Picone, J. Bishop, D. Drob, J. T. Emmert, A. Stephan, D. J. Strickland, A. B. Christensen, L. J. Paxton, D. Morrison, H. Kil, G. Crowley

The TIMED satellite was launched on December 7, 2001 into a near-circular (~ 600 km), near-polar (74.1o inclination) orbit. On board is the Global Ultraviolet Imager (GUVI) instrument, a far ultraviolet (FUV) spectroradiometer that measures the terrestrial dayglow between 120 and 180 nm. GUVI scans the Earths limb (away from the solar direction) and the Earths disk normal to the orbital track. As a consequence, GUVI can obtain thermospheric compositional information both in altitude and in a geographic swath below the orbit. Limb scans measure latitudinal and altitudinal variations of composition and temperature; disk scans measure the geographic distribution of thermospheric column content. Concentration profiles of N2, O2, and O are retrieved systematically from limb scans of spectral bands dominated, respectively, by the OI 135.6 nm and N2 Lyman-Birge-Hopfield dayglow. Mass densities obtained from GUVI show excellent agreement with those derived from drag on space objects, over time scales ranging from a few days to five years. Observations of mass density above 200 km display an increasingly negative bias relative to the NRLMSISE-00 empirical model as solar activity declines below F10.7 = 120, in agreement with drag-based values. Comparisons of mass density, composition, and exospheric temperature with NRLMSISE-00 on various time scales will be presented.

Keywords: thermosphere, composition, climatology

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

JAS008 **Oral Presentation** **497**

A fourteen years monthly climatology in the 35-65 km altitude range from Rayleigh Lidar temperature measurements at a low latitude station

Dr. Paulo Batista
Aeronomy National Institute of Space Research IAGA

Barclay Robert Clemesha, Dale Martin Simonich

A sodium resonance lidar at 589 nm has been operated in So Jos dos Campos, Brazil (23○S, 46○ W) since 1972 mainly for studies related to the origin, chemistry and dynamics of the mesospheric sodium layer. Beginning in 1993, the improved laser capability has enabled also the processing of the Rayleigh signal from which the temperatures from ~35 to ~65 km are retrieved in a nightly mean basis. We used these nightly profiles to determine the monthly temperature profiles from 1993 to 2006. The mean temperature characteristics for every year and for the whole period are obtained. Seasonal thermal amplitude is small (6 K peak to peak at 40 km and 10 K at 65 km).A large difference is noted compared to the MSIS-90 model with temperature lower than the model below the stratopause and higher above. Also the seasonal variation has a large difference with better agreement occurring around local winter, but with a large difference with temperatures higher by ~8-10 K at equinoxes. The semiannual component is dominant over the annual at all altitudes. A linear trend with decreasing temperature is observed from 40 to 60 km.

Keywords: mesosphere, lidar, temperature

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

JAS008 **Oral Presentation** **498**

Long-term changes in temperature fields and global circulation of the atmosphere caused by observed ozone depletion and CO2 increase during last decade of XX Century

Dr. Alexei Krivolutsky
Lab. for Atmospheric Chemistry and Dynamics Central Aerological Observatory IAMAS

Georgy Zakharov, Victor Fomichev, Lidiya Cherepanova

As we know, satellite and ground based observations of ozone has registered a negative trend of global ozone, after 1985, with its minimum near equatorial region and rather high magnitudes at high latitudes of the both hemispheres. This ozone depletion, which was well pronounced in the stratosphere, was often accompanied by increase of ozone in the troposphere. Such stratospheric global ozone depletion has been accompanied by CO2 increase, also well documented. These long-term variations of important radiative-active atmospheric gases has been incorporated into radiative module of middle atmosphere GCM (COMMA/CAO) in order to study a respective long-term changes in temperature and global circulation. It was found in model simulations, that trends in ozone behavior in the stratosphere and mesosphere lead to corresponding negative trends in temperature with the magnitudes, which are rather similar to observations (several K/decade). The region of weak positive temperature trends in the summer polar mesosphere were also found in model runs. Corresponding changes in zonal wind and amplitudes of tides were also calculated. It was shown in simulations that combined effect of atmospheric sedimentation (caused by cooling of the stratosphere) and the increase of ozone content in the troposphere lead to positive temperature trends in this region. Such result seems to be important for the problem of climate change.

Keywords: temperature, circulation, trends

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

JAS008 **Oral Presentation** **499**

Variability of planetary-wave amplitudes as a signature of climatic changes in the stratosphere dynamics

Mrs. Anna Kanukhina
Meteorological Forecasting Department The Russian State Hydrometeorological University
IAGA

Suvorova Ekatherina, Skrygina Eugenia, Pogoreltsev Alexander

The long-term variability of stationary and traveling planetary waves in the lower stratosphere has been investigated using the data of NCEP/NCAR reanalysis. The results obtained show that during the last 60 years the winter-time averaged geopotential height amplitude of the stationary planetary wave with zonal wave number 1 (SPW1) increases at the higher-middle latitudes of the northern hemisphere. It was suggested that the SPW1 amplitude increase should be accompanied by the growth in the amplitude of the stratospheric vacillations. The analysis of the SPW1 behavior supports this assumption and shows a noticeable increase in the amplitudes of stationary wave variability. However, in spite of the rise in the amplitudes of stratospheric vacillations, the amplitudes of longer-period normal atmospheric modes or the so-called 10- and 16-day waves diminish. As it is supposed one of the possible reasons for this decrease in the 10- and 16-day wave amplitudes is the growth of the radiative damping rate caused by CO_2 content increasing in the tropo- and stratosphere. It is noted that increase in the amplitudes of stratospheric vacillations during the last decades indicates that stratospheric dynamics becomes more stochastic. These irregular oscillations of the SPW and mean flow in the stratosphere can be extended into the troposphere as it was demonstrated in the latest papers on the stratosphere-troposphere coupling.

Keywords: climatic variability, normal modes, vacillations

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

JAS008 **Oral Presentation** **500**

The impact of changes in the CO2 concentration on the middle and upper atmosphere sensitivity to doubling base level and gravity wave parameterization

Mrs. Ingrid Cnossen
Physics and Astronomy University of Leicester

Neil F. Arnold, Matthew J. Harris, Alan D. Aylward

We have studied the impact of changes in the CO2 concentration on the middle and upper atmosphere using the Coupled Middle Atmosphere-Thermosphere Model 2 (CMAT2). We have examined a doubling of the CO2 concentration using different base levels and different gravity wave parameterizations, and we have also performed simulations using the CO2 levels from 1965 and 1995, again with varying gravity wave schemes. We find that the impact of a doubling of the CO2 concentration depends on the base level mainly in the thermosphere. Differences between simulations with different gravity wave schemes also occur and are most pronounced in the thermosphere, showing that the impact of changes in the CO2 concentration is not purely radiative, but also dependent on the dynamics. For historical CO2 concentrations,asimple parameterization by Rayleigh friction and a Medvedev-Klaassen scheme result in a much stronger predicted cooling in the thermosphere than a parameterization by a hybrid Lindzen-Matsuno (HLM) scheme. In all cases the cooling predicted by the model underestimates the observed cooling, as do other models. This suggests that other processes than an increase in the CO2 concentration have a substantial cooling effect in this part of the atmosphere. Further work is needed to identify those processes and account for them in atmospheric models.

Keywords: cmat2 model, co2 concentration, gravity wave parameterization

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

JAS008 **Oral Presentation** **501**

Long term trends of foF2 over Antarctica: possible links with the geomagnetic secular behaviour

Dr. Lucilla Alfonsi
Upper Atmosphere Physics Istituto Nazionale di Geofisica e Vulcanologia IAGA

Giorgiana De Franceschi, Angelo De Santis

After several analysis of the foF2 ionosonde data acquired at mid and high latitudes, the result indicates a general decreasing of the F2 plasma frequency over more than two solar cycles. The steeper trends are found over the high latitude stations and, among those, the Antarctic trends seem to be particularly significant. In our recent analysis we have opportunely catalogued the foF2 hourly data according to different levels of magneto-ionospheric conditions to highlight the role of the geomagnetic activity in the secular change of the ionosphere. This approach confirms the latitudinal dependence of the trends and suggests interesting relations with some recent findings on the rapid decrease of the geomagnetic field strength over the whole globe and, more accentuated, in the southern hemisphere. Because of the latter aspect, in this paper we discuss the possible connection with the corresponding ionospheric trends found over Antarctica.

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

JAS008 **Oral Presentation** **502**

SABER observations of solar cycle influence in the mesosphere and lower thermosphere

Dr. Martin Mlynczak
Climate Science Branch NASA L angley Research Center IAGA

F. J. Martin-Torres, R. E. Thompson, D. P. Kratz, R. R. Garcia, S. Solomon, R. G. Roble, B. T. Marshall, J. M. Russell Iii, L. L. Gordley

The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument has been observing the Earths mesosphere and lower thermosphere continuously for 5.5 years, since January 2002. SABER observes infrared emission in 10 discrete spectral bands from 15.5 to 1.27 um. From these observations kinetic temperature, ozone, carbon dioxide, volume emission rates (NO, O2, and OH), atomic species (H, O), rates of solar heating, rates of radiative cooling, and rates of exothermic chemical reactions are derived. SABER has now observed for one-half of a solar cycle, primarily covering the transition from solar maximum to solar minimum. Substantial changes in the thermospheric cooling by both NO and CO2 have been observed, and are strongly correlated with the changes in solar irradiance. We will review the changes observed by SABER in this time period in the thermal structure, chemical composition, and radiative balance, and present comparisons with model calculations.

Keywords: saber, energy balance, solar cycle

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

JAS008 **Oral Presentation** **503**

Long-term trend of the ionospheric F2-layer peak height deduced from EISCAT UHF radar observations

Dr. Tetsuo Motoba

Graduate School of Environmental Studies Nagoya Univ. IAGA

Yasunobu Ogawa, Ryoichi Fujii, Satonori Nozawa

The EISCAT (European Incoherent SCATter) UHF radar at Tromsoe (69.6N, 19.2E) can provide electron density profiles with high temporal and altitude resolution in the auroral ionosphere. A long-time series of the EISCAT common program 1 (CP1: field-aligned component) data between 1984 and 2004 is used to perform ionospheric climatology and long-term trend studies. Since the F2-layer peak height (hmF2) observed by EISCAT can directly be estimated without any assumption, the ambiguity for detecting the real hmF2 is expected to be relatively smaller than that deduced from other ground-based ionospheric instruments, such as the ionosonde. In order to deduce the long-term trend, we need to filter out the dominating effects from solar activity in the hmF2 variations. In previous long-term trend studies, the F10.7 solar radio flux has commonly been used as an index of solar radiation activity. On the other hand, the composite Mg II index is known as a more suitable proxy of the solar extreme ultraviolet (EUV) radiation that ionizes the upper atmosphere, creating the ionosphere. In fact, we find that the observed hmF2 values increase almost linearly with the Mg II index, while they slightly saturate when the F10.7 index exceeds a threshold (approximately 160200). In this study, we therefore filter out the dominating effects of solar activity on the hmF2 variation by replacing the F10.7 index with the Mg II index and attempt to derive possible long-term trend of hmF2 over the last two decades.

Keywords: hmf2, long term trend, eiscat

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

JAS008 **Oral Presentation** **504**

DIAS, European digital Upper Atmosphere Server:a project co-funded by the eContent programme of the European Commission

Dr. Bruno Zolesi
Geomagnetismo, Aeronomia e Geofisica Ambientale Istituto Nazionale di Geofisica e Vulcanologia

Anna Belehaki, Ljiljana Cander, Jurgen Bremer, Christen Juren, Iwona Stanislawska, Mike Hatzopoulos, Dimitri Dialetis, Jan Lastovicka, Benito Antonio De La Morena, David Altadill

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

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

JAS008 **Oral Presentation** **505**

Long term modifications in the Ionosphere at Low Latitudes: Impact of Greenhouse Gases

Mr. Som Kumar Sharma
Space and Atmospheric Sciences Division Physical research laboratory, Ahmedabad, India
IAGA

Harish Chandra

Recently there has been great concern of increasing concentration of greenhouse gases and their direct and indirect impact on the Earth's atmosphere as well as on the Ionosphere Roble and Dickinson (1989) first examined the response of the upper atmosphere to the increased concentration of greenhouse gases and reported a cooling of 10 K and 50 K in mesosphere and thermosphere respectively due to doubling of CO2 and CH4 at 60 km. Rishbeth and Roble (1992) made calculations of the changes in ionosphere due to cooling using the NCAR TIGC (Thermosphere/Ionosphere General Circulation) model. Lowering of the F2 layer peak by about 15 km, on an average, decreases in foF2, of 0.5 MHz at the most were predicted by them. The calculations showed a decrease in electron densities in the topside and a increase in the bottomside (below 200-250 km for low and below 300-350 km for high solar activity periods). We report here the changes in ionosphere observed at two low latitude stations Ahmedabad (23.1o N), situated at the northern crest of Equatorial Ionization Anomaly region, and Kodaikanal (10.2o N), near the magnetic equator. Ionospheric data over Ahmedabad during the period 1955-2004 are analysed. Critical frequencies of the E, F1 and F2 layers and the parameter hpF2 (a measure of the height of F2 layer peak) have been examined for the study of long term ionospheric trends. To remove seasonal variation data are examined for each month separately. Solar cycle variation is removed following the method of Bremer (1992), and trends obtained using both the sunspot number Rz and the 10.7 cm solar flux. The foF2 data at Kodaikanal for 1960-95 are used to estimate the trends. The annual trends for Ahmedabad show a decrease in foF2 of about 1.8 MHz in five decades for midday and about 1.3 MHz for midnight. The lowering of F2 peak by about 12 km during midday and about 14 km during midnight are also observed in this period. An increase of 0.5 MHz in foF1 in about five decades is noted. The results are in agreement with the model predictions of Rishbeth and Roble (1992). Seasonally the changes are least for summer months. The foF2 at Kodaikanal an equatorial station shows a decrease of about 0.6 MHz for midday and 0.8 MHz for midnight in four decades. The results are significant considering the errors in estimation of the trends and the errors in scaling of the ionospheric parameters.

Keywords: long term changes, ionosphere, greenhouse gases

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

JAS008 **Oral Presentation** **506**

Long term changes in the total radio waves absorption in the ionosphere & D- Region over low latitude

Dr. Brij Mohan Vyas
Department Of Physics, M.L.Sukhadia University UDAIPUR (RAJASTHAN) INDIA IAGA

Vimal Saraswat

Study of long term trends in several ionospheric , atmospheric as well as solar geomagnetic parameters has attracted great attention in the recent years due to its great concerns with current scientific environmental global climate changes. Extensive theoretical modeling and experimental finding show that increasing amount of green house gases due to man made activities cause a cooling of the lower and upper ionosphere and same time it causes the increasing of temperature of troposphere. Serafimov and Serafimova argued that measurement of radio waves absorption would be most sensitive indicators of possible climate changes in the ionosphere or possible anthropogenic influences on the mesosphere and lower thermosphere or ionospheric D- region. As radio waves absorption basically depends upon electron density and electron neutral collision frequency , which, in turn, is a function of neutral temperature and neutral density. Therefore, in the present study an attempt has been made in studying the long term changes in the lower ionosphere using the ionospheric D- region as well as Total radio waves absorption data of a low latitude i.e. Udaipur (Geo. Lat. 24.6N , Geo. Long. 73.7E) for the period of 12 years i.e. year 1972 to 1984. Furthermore, the measurement of Atmospheric Carbon Dioxide and derived Tropospheric Ozone from TOMS data of another low latitude close to Udaipur would also be used to correlate with long term changes in Ionospgeric absorption. The details of analysis and results would be discussed and presented .

Keywords: radiowavesabsorption, ionosphere, globalclimatechanges

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

JAS008 **Oral Presentation** **507**

Long-term Temperature Trends in the Thermosphere Based on Incoherent Scatter Radar Data.

Dr. John Holt
Haystack Observatory MIT IAGA

Shunrong Zhang

Starting in 1999, we have developed a series of empirical models of Earth's ionosphere and thermosphere based on data from most of the world's incoherent scatter radars (ISRs). These models depend on solar and geomagnetic activity, but to date do not include any long-term trend independent of those due to differences in geophysical indices from solar cycle to solar cycle. Greenhouse gases such as CO2 and CH4 are well known to be increasing in the lower atmosphere. The effect of this on the upper atmosphere, in particular, the ionosphere, has become an active topic of research since the publication of a theoretical modeling study by Roble and Dickinson suggesting a major greenhouse cooling in the thermosphere in response to increases in CO2 and CH4 concentration at 60 km. This cooling effect leads to a global reduction in neutral densities including O, N2 and total neutral mass density as the neutral temperature Tn decreases. These results, arising from theoretical considerations, have stimulated many investigations of long-term themospheric and ionospheric change, including studies of the trend in hmF2 from ionosonde measurements and observations of thermospheric mass total density by satellites. To date there have been no published studies oft thermospheric cooling as determined by measured temperatures. We have begun to address this using the long-term ISR database which includes direct measurements of ionospheric temperature. Initial results based on daytime data from Millstone Hill collected between 1975 and 2001 show a decreasing temperature trend with an 85% confidence level. We have recently completed the calibration of Millstone Hill data collected since that time. Results based on this expanded data set will be presented in this paper.

Keywords: ionosphere, trends

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

JAS008 **Oral Presentation** **508**

Transient and regional response of climate to natural forcing

Mrs. Tatiana Barlyaeva
Earth Physics Deparment PhD IAMAS

Dmitri I. Ponyavin

Nonlinear techniques and cross-wavelet analysis were applied to the natural timeseries to study interrelations between various temperature reconstructions, solar and volcanic activities on decadal and multidecadal scale. We have found transient and regional response of climate system to external forcing. Long-term trends in the solar and volcanic proxies and their influence on climate variability were analyzed and discussed.

Keywords: cross wavelet analysis, nonlinear techniques

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

JAS008 **Oral Presentation** **509**

Long-term Trends and Solar-Generated Variability in the Atmosphere: A Model Study

Prof. Guy Brasseur
earth and Sun Systems Laboratory National Center for Atmospheric Research IAGA

Hauke Schmidt

The HAMMONIA three-dimensional coupled dynamical/chemical model, which covers the atmosphere from the surface and thermosphere, is used to study the response of the atmosphere to increasing concentrations of trace gases such as carbon dioxide and of changes in the solar radiative energy. The model results will be used together with observations to investigate what has caused trends and variations observed in the past. The response of the dynamical system to chemical and radiative changes will also be discussed.

Keywords: thermosphere

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

JAS008 **Oral Presentation** **510**

Radar and optical observations at Adelaide, Australi

Prof. Iain Reid
Physics School of Chemistry & Physics IAGA

David A. Holdsworth, Daniel Mcintosh, Abas Sivjee, Robert A. Vincent, Jonathan Woithe

This paper presents comparisons of nightglow, MF radar and VHF radar meteor observations using instruments installed at Buckland Park (34.9°S, 138.6°E), Australia. The Buckland Park MF radar has operated continuously since 1984. The Buckland Park ST radar was installed in 2004, primarily for observation of stratospheric and tropospheric echoes, but with external transmit and receive antennas installed to allow all-sky interferometric meteor radar observations. The Adelaide meteor radar was installed in 2003 to allow all-sky interferometric meteor radar observations. It was relocated to Darwin in 2004. A 558 nm photometer has operated continuously at the site since 1995, and an O2 and OH spectrometer since 2001. The intensity of the OI 558 nm nightglow emission exhibits spring and autumn enhancements, bright nights and clear seasonal and interannual periodicities. It also exhibits a solar cycle dependence. Like many other mid-latitude observations, the autumn enhancement is greater than the spring enhancement. A Lomb periodogram analysis of the intensity indicates the presence of annual, semi-annual and quasi-biennial oscillations. The annual and semi-annual oscillations have about equal intensity at this latitude, with amplitudes of between 17 (± 5) % and 14 (± 5) % of the mean intensity respectively. This is consistent with Adelaide being a transitional latitude between a dominant semi-annual oscillation observed at low latitudes and the dominant annual oscillation observed at mid-latitudes. Recently however, Shepherd et al. (2006) have argued for a more complex relationship between latitudinal variations in intensity because of sampling effects of some instruments and tidal variations throughout the year, and this is discussed in the context of our observations. The Quasi-Biennial Oscillation (QBO) has a smaller amplitude in the 558 nm nightglow at about 5 (± 1) % of the mean intensity and takes a maximum value near the autumnal equinox. We note that the MF radar observed diurnal tidal amplitude exhibits a strong inter-annual variability in amplitude at Adelaide. Vincent et al. (1998) found that the variability is strongest at the autumnal equinox when the diurnal tidal amplitude was weaker than a 12-year average in the eastward phase of the QBO and larger than the same average in the westward phase of the QBO. Furthermore, they found that the tidal amplitudes have a semiannual oscillation with maxima at equinox, with the spring amplitudes larger that the autumn amplitudes. The present results are consistent with these observations, and these are discussed in this context. References Shepherd, G.G., Y-M. Cho, G. Liu, M.G. Shepherd and R. G. Roble, Airglow variability in the context of the global mesospheric circulation, J. Atmos. Solar-Terr. Phys., 68, 2000-2011, 2006 Vincent, R.A., Kovalam, S., Fritts, D.C., Isler, J.R., Long-term MF radar observations of solar tides in the low-latitude mesosphere: Interannual variability and comparisons with the GSWM, J. Geophys. Res., 103 (D8): 8667-8683, 1998.

Keywords: nightglow

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

JAS008 **Poster presentation** **511**

Seasonal variation of parameters of F2-Layer and upper ionosphere in solar activity maximum

Dr. Vladimir Klimenko
West Department of IZMIRAN Pobedy Av., 41, Kaliningrad, 236017, Russia IAGA

Bryukhanov Valerij Veniaminovich

In the given work the results of numerical calculations on the Global Self-consistent Model of Thermosphere, Ionosphere and Protonosphere (GSM TIP) the global distributions of parameters of F2-layer and external ionosphere with take into account only dynamo-field, generated by thermospheric winds are presented. The calculations have been executed by completely self-consistent manner for not disturbed conditions of equinox and solstice in maximum of solar activity for 00 UT. It is shown, that the greatest potential difference of dynamo electric field turns out for equinoctial conditions. Equatorial ionization anomaly is formed in all seasons. Thus the crests of anomaly exist in both hemispheres on both sides from geomagnetic equator. The middle-latitude trough in critical frequency of the ionospheric F2-layer in solstice is deeper, than in equinox and occupies a greater area. Thus the deepest and extensive trough is formed in summer in a winter hemisphere. Middle-latitude winter anomaly is more precisely shown in summer conditions, than in winter. Concentration of electrons, Ne, and ions H+, n(H+), at height of 1500 km is higher in all summer hemispheres in a solstice also do not experience sharp troughs. In winter hemispheres in the summer and in the winter troughs in Ne and in concentration of light ions H+ are formed. In equinox the troughs in Ne and in n(H+) are formed in both hemispheres, but they less deep, occupy the smaller area and located farther from poles. In summer hemispheres in a solstice the ion temperature at height of 1500 km is high in auroral zones and falls down to poles. In equinox and in winter hemispheres of solstice the heating of ions occurs on the night side. Thus the temperature of ions in the heating region is higher then temperature of electrons. The electrons at the same height heat up on the dayside of winter hemispheres in a solstice more weakly. During the same seasons the cooling processes of electrons are the least on the night side of summer hemispheres. The heating of electrons at height 1500 km occurs in all seasons on the dayside.

Keywords: ionosphere, anomaly, modeling

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

JAS008 **Poster presentation** **512**

Forced redistribution of air masses between Southern and Northern Hemispheres of the Earth

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

On the basis of a geodynamic model (Barkin, 2002) it has been shown, that in the Earth atmosphere should be observed regular cyclic changes of air masses between northern and southern (N-S) hemispheres, caused not only by climatic factors, but also by the gravitational influence of displaced superfluous mass of the Earth core. Alongside with annual, semi-annual and others cyclicities, the secular inversion component in change of atmospheric masses of the N-S hemispheres should be observed. On our model in present epoch the mass of atmosphere in northern hemisphere increases. Also it was discovered, that the mentioned changes are not strictly mirror, and there is a certain asymmetry between hemispheres. It concerns both to air masses of hemispheres, and to their cyclic variations. The specified asymmetry results in secular and cyclic variations of tensor of inertia of the Earth and to variations of its rotation (Barkin, 2001). The basic dynamic reason of the discussed exchanges in masses between hemispheres is the gravitational influence of the displaced Earth core (of its superfluous mass) on atmosphere. The small displacements of the core relatively to elastic mantle are forced and determined by the differential gravitational action of the Moon and the Sun on both eccentric and non-spherical the core and the mantle of the Earth. The change of masses of atmosphere in hemispheres carries an inversion character. If in the northern hemisphere the mass of atmosphere increases, approximately in the same way it decreases in the southern hemisphere. Then the situation varies on opposite. The basic types of relative displacements of the core and the mantle with annual, semi-annual, two-annual and other cyclicities were restored on the available observable data about the geocenter motion. On our geodynamic model in redistribution of atmospheric masses of N-S hemispheres the inversion variations with periods: (in years) 4.45, 2, 1.3 and (in days) 410, 232, 140, 120, 110, 99, 88, 70, 31, 27, 20, 18, 13.5 etc. should be observed (Barkin, Lyubushin, Zotov, 2007). The oscillations of the Earth centre of mass with amplitudes from 15 mm to shares of mm characterize the identical oscillations of the core with amplitudes approximately in 5 times big. On our model it is necessary to expect of similar inversion variations of masses of atmosphere in northern and southern hemispheres (and, probably, in east and western sectors) with the hour periods: 12.0, 8.0, 6.0, 4.8, 4.0, 3.43, 3.0, 2.67, 2.4 (Barkin, 2005). Corresponding hour periods must be observed in geocenter (and the core) motion. The attraction of superfluous mass of the moving core causes the atmospheric tides and inversion in redistribution of air and fluid masses. The process of asymmetrical secular redistribution of the Earth masses was effectively modeled by point model (Barkin, 2001). Two points model an asymmetric mass accumulation in the Earth N-S hemispheres due to transformations of the top layers of the Earth. In the northern hemisphere the mass of point increases with velocity 5.00x10 (14) kg/yr, and in southern hemisphere the mass of point decreases with velocity -2.78x10 (14) kg/yr. Points are situated at the poles of geocentric axis directed to the geography point 70 N, 103.4 E. The model has been used for an explanation of such fundamental phenomena as the secular pole drift and not tidal secular acceleration of the Earth (Barkin, 2001). To the mentioned mass variations can be compared some secular variations of the mean pressure of atmosphere (loadings) at the surface of N-S hemispheres with velocities Pn = 0.196 (g/sm2)/yr and Ps =-0.109 (g/sm2)/yr. The specified values is coordinated well with empirical estimations of slow changes of average atmospheric pressure in northern and southern hemispheres with velocities 0.17-0.22 mbar/yr and 0.18 mbar/yr (Burluzkii, 2007; according to observation data over the period April 2002 - April 2005). Thus atmospheric masses give the basic contribution to expected secular redistribution of masses between hemispheres. The

asymmetry in mass redistribution is determined by change of atmospheric and oceanic masses and subsoil waters. All fluid masses and even subducting lithosphere plates bring definite contributions in the directed reorganization of the Earth. Referenses 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. Barkin, Yu.V. (2001) Explanation and prediction of the secular variations of the Earth rotation, geopotential, force of gravity and geocenter drift. Proceedings of International Conference "AstroKazan-2001". Astronomy and geodesy in new millennium (24-29 September 2001), Kazan State University: Publisher "DAS", pp. 73-79. Barkin Yu.V., Lyubushin A.A., Zotov L.V. (2007) Motion of a geocenter and its geodynamic contents. Materials of Sagitov Conference (Moscow, 5-6 February 2007). GAISH, MSU (www.sai.msu.ru). Burluzkii R.F. (2007) Determination of the global concentration of pair on the ground pressure. Materials of Sagitov Conference (Moscow, 5-6 February 2007). GAISH, MSU (www.sai.msu.ru).

Keywords: redistribution, air, masses

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

JAS008 **Poster presentation** **513**

Possible mechanism of superrotation of the atmosphere in Southern and Northern Hemispheres of the Earth (and others planets)

Prof. Yury Barkin
Laboratory of Gravimetry Sternberg Astronomical Institute IAG

One of the fundamental conclusions obtained on the basis of geodynamic model about forced relative displacements of the core and elastic mantle under of gravitational attraction of external celestial bodies is the conclusion about polar drift of the Earth core to North Pole (Barkin, 1995; 2002). This phenomenon has obtained wide confirmations in the data of observations of geocenter motion, in gravimetry measurements, in geodesy determinations of heights variations and in geoid form variations, in many geophysical and geodynamical phenomena (Barkin, 2005; 2006). It has formed a basis for other assumption - about the existence of a slow secular redistribution of air (and, in general, oceanic and fluid) masses from southern hemisphere in northern hemisphere of the Earth. This phenomenon is analogue of observable annual redistribution of atmospheric masses between northern and southern hemispheres (the change about 4.5x10(15) kg), the significant contribution in which also brings the mechanism of gravitational influence on the atmosphere of superfluous mass of the core executing annual polar oscillation with amplitude about 21 mm. The maximal displacement of the core to the North takes place in the beginning of year. In this period the maximal mass of atmosphere in northern hemisphere is observed. As the secular drift of the core takes place (in the direction of North Pole) on a background of described above of annual inversion change of masses between N-S hemispheres of the Earth the slow monotonous tide of atmospheric masses in northern hemisphere should be observed. From comparison of amplitude of annual oscillation of the core and velocity of its secular drift in present period we obtain an estimation for velocity of "secular" increasing of atmospheric mass in the northern hemisphere. Namely, the mass of atmosphere in northern hemisphere accrues with velocity about 0.4-0.5x10 (15) kg/yr. The core drift to North Pole results in constant escalating fluid masses in northern hemisphere (in the present epoch). As consequence of this fundamental process, the polar moment of inertia of atmosphere of northern hemisphere will be increased. From a condition of a constancy of the relative angular momentum of atmosphere of northern hemisphere we come to a conclusion, that angular velocity of rotation of this part of atmosphere relatively to the Earth surface (as a similar rigid body) will decrease. Its velocity of decrease will be slowed down, however, by the continental formations creating natural obstacles. In the southern hemisphere the opposite tendency takes place. Here at decrease of mass of atmosphere its rotation will be increased, and at smaller resistance of continents. It is possible to assume, what exactly influence of east winds on continental spaces results in cumulative effect of a superrotation of full atmosphere. The resistance of continental spaces as though results in the phenomenon of the western rotation of atmosphere. If the specified tendency really has taken place many years so the backlog of rotation of atmosphere of northern hemisphere from rotation of atmosphere of southern hemisphere in present epoch should be observed. The observational data confirm the described global atmospheric phenomenon. "Period of superrotation of atmosphere of southern hemisphere relatively to the Earth surface makes 58 days, and for the atmosphere of northern hemisphere makes 92 days." (Sidorenkov, 2002). In present epoch due to the redistribution of the air masses caused by the gravitational attraction of superfluous mass of the core, drifting in the direction of the north, velocity of rotation of the atmosphere of northern hemisphere in east direction is slowed down, and velocity of rotation of the atmosphere of southern hemisphere in east direction is increased. The similar inversion of relative 'twisting' of atmospheres of hemispheres is made also cyclically, for example, with annual or other periods. According to our dynamic constructions in the beginning of year the angular velocity of rotation of atmosphere of northern hemisphere in the western direction, and atmosphere of the southern hemisphere - in east direction have the maximal values. Approximately in half-year the situation varies on opposite. At the end of summer the angular velocity of rotation of the atmosphere of northern hemisphere in east direction, and atmosphere of the southern hemisphere - in the western direction again accept the maximal values. These conclusions also prove to be true by the data of modern observations. The similar phenomena should be observed in atmospheres of other planets (Mars, Venus and others) and the Sun.

Keywords: hemispheres, superrotation, inversion

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

JAS008 **Poster presentation** **514**

A study of ionospheric climatology by using GPS phase fluctuations at Taiwan-Philippines longitudes

Dr. Fangdar Chu
National Standard Time and Frequency Lab Telecommunication Laboratories IAGA

C. C. Lee, W. S. Chen, J. Y. Liu

We examined ionospheric plasma irregularities observed during the years of 2000-2006 (more than a half of solar cycle and including both solar maximum and minimum periods) by using several ground-based receivers of the global positioning system (GPS) located at Taiwan-Philippines longitudes. It is notable that Taiwan locates near the crest of the northern equatorial ionization anomaly and Philippines locates near the magnetic equator. The primary statistic results showed that the distribution of the occurrence probability of GPS phase fluctuations appears a two-peak pattern and at its two peaks in equinoctial months during both solar maximum and minimum periods. In addition, as solar activity increases, the occurrence probability of GPS phase fluctuations increases. The implications of the statistic results of GPS phase fluctuations will be discussed, and the results observed in both regions of the equatorial ionization anomaly and the equator will be compared.

Keywords: ionosphere, irregularity, gps

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

JAS008 **Poster presentation** **515**

Long-term trends in the amplitude range of the daily geomagnetic field variation

Dr. J. Miquel Torta
Observatori de lEbre CSIC - Universitat Ramon Llull IAGA

David Altadill, Juan J. Curto, Luis R. Gaya-Piqu

This paper attempts to reveal whether long-term trends in the ionosphere are reflected in the amplitude range of the geomagnetic daily variation recorded at ground level. The smooth and regular variation observed in the magnetograms on magnetically quiet days is induced by the ionospheric current system flowing in the dynamo region. So it is highly likely that trends in the conductivity or in the dynamics of this region could produce changes in the current densities, and consequently in the range of the geomagnetic variation. The crucial aspect is how to separate the changes produced by the geomagnetic activity itself, or by secular changes of the Earths magnetic field, from the part of the variation produced by factors affecting trends in the ionosphere, which could have an anthropogenic origin. To investigate this, we synthesized for several geomagnetic observatories the daily ranges of the geomagnetic field components with a comprehensive model of the quiet-time, near-Earth magnetic field, and finally we removed the synthetic values from the observed ranges at those observatories. This comprehensive model accounts for contributions from Earths core, lithosphere, magnetosphere and coupling currents, and, additionally, accounts for influences of main field and solar activity variations on the ionosphere. Therefore, any trend remaining in the residuals, assuming that all the contributions mentioned above are properly described and thus removed by the comprehensive model, should reflect the influence of other sources. Preliminary results, based on series of magnetic data from observatories worldwide distributed, are presented.

Keywords: sq, trends

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

JAS008 **Poster presentation** **516**

Long Term Plasma Density variations of Sporadic E Layer and its Association with Meteor Activity over Ahmedabad

Mr. Som Kumar Sharma
Space and Atmospheric Sciences Division Physical research laboratory, Ahmedabad, India
IAGA

Harish Chandra, H S S Sinha

The variations in plasma density of the E layer is highly irregular and is not a smooth function of solar zenith angle. Because of irregular variations in the plasma density, this layer is more commonly known as sporadic E layer or Es layer. Sporadic E layer plays vital role in radio communications. It is generally believed that Sporadic E layers are formed by the compression of the metallic ions (Fe+, Na+, K+ etc) of meteoric origin by the wind shear mechanism. In the present study an attempt is made to identify the periods of unusually high plasma density of ES-layer by using the hourly ES values recorded at Ahmedabad (23.10o N, 72.36o E), which is an important ionospheric station near the northern crest of Equatorial Ionization Anomaly (EIA) in the India. Data has been analyzed for a period of 1978 2002 with a view to see the effect of low, medium and high solar activity and also the seasonal effects. Special emphasis has been given to the periods of Leonid Meteor showers. The Leonid meteor shower is known to have strong activity every 33 years, which is the period of Tumpel - Tuttle, the parent comet of the shower. A meteor outburst of Leonid was observed in November 1994 and strong meteor shower was predicted to occur in 1998 or in 1999. A strong event of meteor burst was observed at the time of the descending node of the comet at 1331 hrs (UT) on 17 November 1998. Special rapid radio soundings (every minute during expected peak of the shower and every five minutes otherwise) were made over Ahmedabad to study the effects of the Leonid meteor shower on the ionosphere during 16 - 20 November of the years 1998, 1999 and 2000, 2001. Hourly Ionospheric data recorded over Ahmedabad for the years 1993-2001 indicate a distinct increase in the occurrence of Sporadic-E during the Leonid shower days. The daily mean percentage occurrence of Sporadic-E is peaking in the year 1998. Considering the days from 17-19 November only, the percentage occurrences are 15%, 40% and 40 % in 1994, 15 %, 20% and 50% in year 1995, 40%, 50% and 35% in 1996, 50%,60% and 20% in 1997, 75%,80% and 40% in 1998,10%,50% and 10% in 1999 and 22%,58% and 55 % in year 2000 and even less during 2001. The occurrence of Sporadic-E, presence of multiple traces, magnitude of foEs and fbEs are rather low in year 1999, 2000 and 2001 than in year 1998. A comparison with other prominent meteor showers event data indicates that the high values of Es are mostly correlated with the meteor shower activity. The variation of plasma density of Es layer with meteor activity during this period will also be presented.

Keywords: plasma density, sporadic e, meteor showers

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

JAS008 **Poster presentation** **517**

Peculiarities of Impact of Greenhouse Gases on the Expected Recovery of the Ozone Layer in the Polar Regions

Dr. Alexander Zadorozhny
Division for Atmospheric Research Novosibirsk State University IAGA

Igor Dyominov

A numerical 2-D zonally averaged interactive dynamical radiative-photochemical model of the ozonosphere including aerosol physics is used to examine the role of the greenhouse gases CO_2, CH_4, and N_2O in the future long-term changes of the Earths ozone layer, in particular in its recovery after reduction of anthropogenic discharges of chlorine and bromine compounds into the atmosphere. The model allows calculating self-consistently diabatic circulation, temperature, gaseous composition of the troposphere and stratosphere at latitudes from the South to North Poles, as well as distribution of sulphate aerosol particles and polar stratospheric clouds (PSCs) of types I and II. The scenarios of expected changes of the anthropogenic pollutants for the period from 1980 through 2050 are taken from Climate Change 2001. The processes, which determine the influence of anthropogenic growth of atmospheric abundance of the greenhouse gases on the dynamics of recovery of the Earths ozone layer in the Polar Regions, have been studied in details. Expected cooling of the stratosphere caused by increases of greenhouse gases, most importantly CO_2, essentially influences the ozone layer by two ways: through temperature dependencies of the gas phase reaction rates and through enhancement of polar ozone depletion via increased PSC formation. The model calculations show that a weakness in efficiencies of all gas phase catalytic cycles of the ozone destruction due to cooling of the stratosphere is a dominant mechanism of the impact of the greenhouse gases on the ozone layer in Antarctic as well as at the lower latitudes. This mechanism leads to a significant acceleration of the ozone layer recovery here because of the greenhouse gases growth. On the contrary, the mechanism of the impact of the greenhouse gases on the ozone through PSC modification begins to be more effective in Arctic in comparison with the gas phase mechanism in springs after about 2020, which leads to retard the expected recovery of the ozone layer here. The mechanism of the impact of the greenhouse gases on the polar ozone by means of modification of sulphate aerosol distribution in the atmosphere has been revealed and investigated, too. Numerical experiments show that enhancement of the surface area density of sulphate aerosol in the stratosphere caused by the growth of the greenhouse gases will reduce significantly the ozone depletion during the Antarctic ozone hole. As for the global total ozone, continuous anthropogenic growth of the greenhouse gases will lead to significant acceleration of its recovery. In the case of the used scenario of expected long-term changes of the greenhouse gases, the global ozone will reach its undisturbed level of 1980 by about 2043. If the CO_2 growth stops, the global total ozone will reach this level only by the end of the 21st century.

Keywords: ozone, recovery, stratosphere

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

JAS009 **518 - 568**

Symposium
Equatorial atmosphere-ionosphere coupling processes: responses to forcing from lower atmosphere and magnetosphere

Convener : Dr. Mangalathayil Abdu

The earths equatorial latitudes offer unique conditions for investigating the dynamical and electro-dynamical coupling processes that govern the atmosphere-ionosphere system and its interaction with the magnetosphere and interplanetary medium. Upward transport of wave energy and momentum due to gravity, tidal and planetary waves from below and extra-tropics control the phenomenology of the equatorial atmosphere -ionosphere system and its large zonal, day-to-day and interannual variabilities while magnetospheric /interplanetary forcing through disturbance electric fields and energy deposition at high latitudes with the consequent coupling to equatorial latitudes represent another important source of variability of the system. In recent years important new results have come out from ground based as well as space borne observations and simulation studies on the different sources of variabilities of the system. This symposium will address all aspects of the dynamics and energetics governing the atmosphere- ionosphere- magnetosphere- interplanetary coupling processes of the equatorial region. Results are welcome from ground based and satellite borne experiments, and from modeling investigations, on the dynamics and electro-dynamics, and manifestations of coupling process, (such as responses to magnetic storms and upward propagating atmospheric wave disturbances etc.), in terms of small and larges structures, and variabilities in winds, temperatures, waves, plasma drifts, electric fields and currents, in general, and especially, those related to the major phenomena of the region: Equatorial plasma bubbles/Spread F, Ionization Anomaly and Electrojet

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

JAS009 **Oral Presentation** **518**

Investigation of dependence of substorm effects in equatorial electrojet and parameters of F-Region of ionosphere on the separate stations from ut substorm beginning on the basis of GSM TIP

Mr. Maksim Klimenko
Kaliningrad State Technical University, Phys. Dep. Sovetskij Av., 1, Kaliningrad, 236000, Russia IAGA

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 equatorial electrojet from which the intensity time course of westward and eastward equatorial electrojet has been constructed was calculated. Calculations have shown, that during the substorms beginning in 06 UT and 18 UT, there is a reduction of intensity of the counter electrojet from - 12 A/km in quiet conditions up to - 4 A/km; during the substorms beginning in 00 UT, there is the counter electrojet easing from - 8 A/km in quiet conditions up to - 4 A/km, and during the substorms beginning in 12 UT, the counter electrojet practically does not vary. At the same time the eastward equatorial electrojet intensity during the substorms beginning in 00 UT and 12 UT decreases from ~50 A/km in quiet conditions up to ~40 A/km; during a substorm beginning in 06 UT, its intensity decreases up to ~15 A/km, and for a substorm beginning in 18 UT, it in the beginning grows up to 65 A/km, and then falls up to 40 A/km. 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 geomagnetic equator the precise semidiurnal harmonic in foF2 perturbations with maxima of positive disturbances in post-sunset and pre-sunrise hours and maxima of negative disturbances in post-midnight and near-midday hours is traced. Negative ionospheric disturbances are observed mainly at night from subauroral latitudes up to geomagnetic equator. By the moment of the substorm termination the positive disturbances in the post-sunset sector at geomagnetic equator considerably amplify. Calculation results of the foF2 temporal course during substorms are submitted and analyzed for equatorial, low- and mid-latitude stations Jicamarca, Fortaleza, Ujjain, Okinawa, Tashkent, Rome and Graz.

Keywords: ut variation, electrojet, substorm

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

JAS009 **Oral Presentation** **519**

An observational study on MJO in West Sumatera, Indonesia based on the EAR, BLR, OLR, MAWS

Dr. Eddy Hermawan
Center for Application of Atmospheric Sciences National Institute of Aeronautics and Space (LAPAN IAGA

Tri Wahyu Hadi, Findy Renggono, Mega Puspawardhany, Sopia Lestari, Fikri Muhammad Abdul Wahab

The Madden-Julian Oscillation (MJO) is the dominant mode of intraseasonal variability in the tropical atmosphere (Madden and Julian, 1994). It consists primarily of large-scale (approximately 1000 km across) deep convective tropical rainfall anomalies that propagate slowly eastward from the Indian Ocean, through the maritime continent of Indonesia, and into the western Pacific, where they decay at around the date line. The time taken for one such MJO event is typically between 30 and 60 days. Such patterns have been extensively documented using satellite-measured Outgoing Longwave Radiation (OLR) data as a proxy for tropical rainfall. In this study, we mainly concerned to the analysis of MJO when passing over Kototabang, West Sumatera using the Equatorial Atmosphere Radar (EAR), Boundary Layer Radar (BLR) and other instrument facilities, suh as Mini Automatic Weather System (MAWS) and Optical Rain Gauge (ORG), especially during the wet season of November 1, 2002 to February 28, 2003. We used the global OLR data also at position of 100E to investigate the propagation of super cloud cluster (SCC) selected nearby Kototabang. The zonal-vertical of EAR data analysis from November 1, 2002 to February 28, 2003 shows that the Westerly wind mostly moves at below 2.5 km, while the Easterly wind mostly moves between 2.5 to at around 17.7 km. We found a nicely variation of zonal wind at around 2.5 km when the reversal wind of Westerly and Easterly appreared. This looks consistent with the daily OLR anomaly data analysis with the most convective activity is occured from November 13, 2002 to January 10, 2003. Then, we concentared to analyze the Power Spectral Density (PSD) of zonal wind velocity variation at several altitude height of 2.05 km, 2.19 km, 2.34 km and 2.49 km, respectively using the Fast Fourier Transform (FFT) technique. We found that all PSD patterns are similar each other, but the heightest value is located at around 2.49 km about 35 days oscillation. This is also consistent with the Temperature Black Body (TBB) data analysis over Kototabang from November 2002 to February 2003. We found the 35 days oscillation as an initial condition of MJO phenomena. The most important point is when we compared the zonal wind velocity variation and rainfall intensity represented by the MAWS and ORG, especially at about 2.5 km altitude height. We found that the increasing of zonal wind velocity, especially Westerly is not always following by the increasing of rainfall intensity, both MAWS and ORG data. The Cross Correlation Function (CCF) analysis using the SPSS software between of them relatively is very small (below 0.25) with lag-time is 1. But, we found an a good pattern between the daily OLR anomaly and rainfall intensity, especially from January 1 to February 28, 2003 when the rainfall intensity is very small. Although, the statistical analysis between of them still is being done, but we can mention here that the rainfall intensity over Kototabang and surrounded area is mostly effected by the daily variation of OLR data anomaly.

Keywords: ear, olr, mjo

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

JAS009 **Oral Presentation** **520**

Effects of penetration electric fields on equatorial plasma bubbles

Dr. Cheryl Huang
Aeronomy Air Force Research Laboratory IAGA

William J. Burke

Satellites of the Defense Meteorological Satellite Program (DMSP) detect equatorial plasma bubbles (EPBs) that reach altitudes > 840 km. The deepest depletions coincide with the main phases of magnetic storms. The cause of the enhanced depletions has been attributed to penetration electric fields which occur when large cross-polar cap potentials are imposed by the solar wind on the coupled magnetosphere-ionosphere system. This effect is repeatedly seen in our database of DMSP observations of EPBs which extends across 15 years. Multi-point satellite observations show that the addition of a penetrating electric field to the basic Rayleigh-Taylor instability causes a shift in EPBs detections to earlier local times. We have developed a simple model of the coupled electric field based on the Volland-Stern approach, combining a corotation field close to the Earth with dawn-to-dusk magnetospheric electric field. The model requires interplanetary parameters (e.g. IMF, solar wind pressure) as input to predict the strength of penetration electric fields and the main phase development of Dst when the deepest stormtime EPBs are observed. Given the availability of solar wind input, the model provides about an hour advance notice about the onset and duration of large and potentially disruptive EPBs.

Keywords: storms, electric, depletions

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

JAS009 **Oral Presentation** **521**

Evidence of atmosphere ionosphere coupling obtained during the spread Fexperiment (SpreadFEx): a campaign overview

Dr. Dave Fritts
Colorado Research Associates NWRACoRA IAMAS

The principal focus of the Spread F Experiment (SpreadFEx) was to address the potential seeding of equatorial spread F (ESF) and plasma bubbles penetrating to high altitudes by gravity waves (GWs) propagating into the ionosphere from deep convective sources occurring over the Amazon Basin. A Brazilian and U.S. research team performed two SpreadFEx measurement campaigns in Brazil from September to November 2005 during

Keywords: equatorial spread f, gravity waves, convection

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

JAS009 **Oral Presentation** **522**

He+ Density depletions (bubbles) and thermosphere meridional wind

Dr. Larissa Sidorova
IZMIRAN Russian Academy of Science IAGA

Sergey Vitalvich Filippov

The present study deals with the evaluation of the possible contribution of the thermosphere meridional/transequatorial winds in the diurnal occurrence probability of the equatorial and low-latitudinal plasma bubbles. It is suggested, that the plasma bubbles, produced by Rayleigh-Taylor instability at the bottomside of ionosphere and transported up by buoyancy to the topside ionosphere and plasmasphere, could be strong affected by meridional (poleward) wind during a generation due to inhibiting the growth of Reyleigh-Taylor instability and flux tube integrated conductivity. He+ density depletions, considered as originating from equatorial plasma bubbles phenomena, or as possible fossil bubble signatures, are studied here. He+ density depletions (or subtroughs) are usually observed during a high solar activity at the topside ionospheric altitudes deeply inside the plasmasphere (L~1.3-3). The diurnal He+ density depletion statistics, obtained from ISS-b satellite data (1978-79) for the different months and averaged for the periods around the solstices and equinoxes, was compared with the velocity variations of the meridional thermosphere wind, calculated in the different models. The best amplitude correlation was found in the longitudinal region of 0˚-60˚W for winter solstice (R=0.72), when the model calculation of Maruyama (1996) was used. The magnetic meridional component of the thermosphere wind was calculated in this model for declination angle of 20˚. He+ density depletion distribution as function of latitude-longitude, longitudinal statistics and the map of the magnetic declination angle, calculated from IGRF 1975, were involved for further analyses. It was concluded that the significant modulation effect is determined by season and declination angle of the earth magnetic field in the equatorial region.

Keywords: he density depletions, thermosphere meridional wind, correlation

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

JAS009 **Oral Presentation** **523**

Global Ionospheric Weather observed by the FORMOSAT-3/COSMIC

Dr. Chien-Hung Lin
Science Research Development National Space Organization IAGA

Chun-Chieh Hsiao, Jann-Yenq Liu, Ho-Fang Tsai, Chao-Han Liu

The FORMOSAT-3/COSMIC constellation, consisting of six micro-satellites in the low-Earth orbit, is capable of monitoring the global ionosphere by using the powerful technique of radio occultation. With more than 2500 observations per day, it provides an excellent opportunity to monitor the three-dimensional ionospheric structures and associated dynamics. In this talk, the ionospheric seasonal variations, atmosphere-ionosphere coupling, and solar flare and magnetic storm effects to the ionosphere are studied using the FORMOSAT-3/COSMIC observations. For the seasonal variations, we discuss the competing processes between the equatorial plasma fountain and the neutral wind effects by examining the diurnal variations of the ionosphere structure in meridional direction. Longitudinal variation of the equatorial ionosphere at various altitudes, believed to be influenced by the upward propagating atmospheric tides, is clearly observed by the constellation. Solar flare and magnetic storm effects to the electron density profiles at different latitudes and longitudes/local-times are also studied together with the total electron content (TEC) observations from global GPS receiver networks. Additionally, a new equatorial ionosphere feature, plasma caves, is found underneath the two equatorial anomaly crests based on FORMOSAT-3/COSMIC observation. The plasma caves are well-developed during the daytime when the equatorial plasma fountain becomes prominent. We will present the spatial and temporal variations of the plasma caves and discuss the formation mechanism.

Keywords: formosat 3, ionosphere

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

JAS009 **Oral Presentation** **524**

Ionospheric positive storm phase: a model-data comparison

Dr. Gang Lu
High Altitude Observatory National Center for Atmospheric Research IAGA

Larisa Goncharenko, Arthur Richmond, Raymond Roble, Nestor Aponte

This paper presents the observations and numerical simulations of the ionospheric and thermospheric responses to the 10 September 2005 geomagnetic storm. A positive storm phase was observed by incoherent scatter radars in Millstone Hill and Arecibo. The altitude profiles of electron density as measured by the radars displayed an inverted V structure, and the similar electron density distribution was also reproduced by the Thermosphere-Ionosphere Electrodynamics General Circulation Model (TIE-GCM). This peculiar F-region electron density altitude profile was associated with vertical ion drift, which initially was upward and then became downward. Using realistic, time-dependent plasma convection and auroral precipitation as inputs, the TIE-GCM revealed that the primary cause of this positive storm phase was the neutral wind dynamo field generated by traveling atmospheric disturbances (TADs) instead of penetrating magnetospheric electric field. This study reiterates the importance of neutral wind dynamo effects on ionospheric disturbances.

Keywords: ionosphericdisturbances, mid andlow latitudeionosphere, thermosphericdynamics

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

JAS009 **Oral Presentation** **525**

Observations of the low latitude solar eclipse on 8 April 2005 by CHAMP

Dr. Ana Teresa M. Tomas
Section 2.3 - Earth magnetic field GFZ Potsdam IAGA

Hermann Luehr, Matthias Foerster, Stefanie Rentz, Martin Rother

Measurements of ionospheric and thermospheric parameters obtained by the CHAMP satellite were analyzed for the time period of the solar eclipse 8 April, 2005. We have analyzed the electron density and temperature, as well as the thermospheric mass density and the neutral wind velocity. Due to the location of the eclipse close to the equator a study of the equatorial electrojet is also included. During closest approach CHAMP passed the region of 30% obscuration. Significant modifications of the ionosphere at F2 layer altitudes could be observed. The plasma fountain at the equator is strongly enhanced resembling post-sunset conditions. The thermospheric mass density and zonal wind show no eclipse related effect. The equatorial electrojet strength is reduced by almost 40%. This is about twice the amount expected from E-region electron depletion at the CHAMP footprint.

Keywords: solar eclipse, eej, ionosphere

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

JAS009 **Oral Presentation** **526**

Coupling in the magnetosphere-ionosphere-atmosphere system during October 30, 2003 superstorm.

Dr. Olga Verkhoglyadova
IGPP University of California at Riverside

Bruce T. Tsurutani, Anthony J. Mannucci, Akinori Saito, Tohru Araki, Toshitaka Tsuda, Kiyohumi Yumoto, David Anderson

We will present a physical mechanism of coupling in the magnetosphere-ionosphere-atmosphere system during strong magnetic storms. The example of October 30, 2003 event will be analyzed. A relationship between the southward turning of the interplanetary magnetic field and positive ionospheric storm will be revealed. Our numerical simulation results and estimates will show that the prompt penetrating electric field (PPEF) causes a superfountain effect which leads to uplift of the dayside ionosphere. Both electrons and ions are uplifted to ~600 km and latitudes of 20-30 degrees. The TEC at middle latitudes can increase by the factor of 6. The ion-neutral drag can cause uplift of the atmosphere and can produce additional deceleration for the low-orbit satellite. Comparison with observations will be presented.

Keywords: ionosphere, ppef, suprefountain

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

JAS009 **Oral Presentation** **527**

Storm time electric fields and ionosphere/thermosphere responses over low latitudes

Prof. Bela G. Fejer
Center for Atmospheric and Space Sciences Utah State University IAGA

The low latitude ionospheric plasma drift, currents, and plasma density can be strongly affected, within a large range of times, by prompt penetration and ionospheric disturbance dynamo electric fields during geomagnetic storms. We use vertical plasma drift measurements from the Jicamarca Radio Observatory, magnetic field observations from the Pacific region, and solar wind and magnetospheric measurements to examine the effects of solar wind pressure and electric field perturbations and magnetospheric disturbances on equatorial prompt penetration vertical plasma drifts during large geomagnetic storms. Solar wind pressure increases drive very short-lived (time constants of a few minutes) equatorial prompt penetration electric fields consistent with increases in the cross-polar cap potential. We also present equatorial vertical plasma drift perturbations during the main phases of various geomagnetic storms. Our results indicated that, contrary to some recent suggestions, the equatorial prompt penetration electric fields are relatively short-lived (lifetimes shorter than about 1-2 hours) even during periods of large eastward electric fields. High time resolution equatorial ionospheric and solar wind electric field measurements also indicate that the ration of these two parameters can change significantly in relatively short time periods. Our experimental results will be compared with recent numerical simulations using global convection models.

Keywords: electric fields, ionosphere thermosphere, low latitudes

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

JAS009 **Oral Presentation** **528**

6-hr variation of thermospheric meridional wind at low latitudes as deduced from a meridional ionosonde network

Dr. Takashi Maruyama
Applied Electromagnetic Research Center NICT IAGA

Masabumi Kawamura, Kenro Nozaki, Susumu Saito, Hisao Kato, Mamoru Ishii

Meridional ionosonde chain at low latitudes has a great capability for studying thermosphere-ionosphere coupling processes. The ionospheric height difference between a pair of magnetic conjugate points can be used to infer a transequatorial neutral wind component. Thus obtained wind is a mean at both the locations. On the other hand, there could be a case in which the layer height increases at both the conjugate points, which might be caused by an upward EXB drift and/or a wind converges towards the magnetic equator. It is difficult, however, to separate these two effects from observations at conjugate points only. Whereas, height variations at the magnetic equator are effective to infer the vertical drift due to a zonal electric field, because the magnetic field line is horizontal and the layer height is not affected very much by winds. Putting ionospheric height data from the equatorial and low latitude conjugate stations together, we can infer not only transequatorial winds but also convergence/divergence (with respect to the magnetic equator) winds. After sunset, virtual heights directly scaled from ionograms, hFs, are a good indicator of the real height of the ionosphere. Thermospheric wind characteristics are examined through the assistance of model calculations, which includes a vertical EXB drift effect determined by fitting the height variation at the magnetic equator to reproduce the observed height. The results are compared with an empirical thermospheric wind model, HWM93. Although the HWM93 wind reasonably describes the height variations, there found significant higher-order variations in height during the northern solstice and equinoxes. The HWM93 model contains terdiurnal (8-hour) or lower-order components of diurnal pattern, while the observed height variations have a 6-hour periodicity. Possible connections with atmospheric tide and the midnight temperature bulge will be discussed.

Keywords: ionosonde chain, neutral wind, tide

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

JAS009 **Oral Presentation** **529**

Dynamical Response of the Tropical Stratosphere-Mesosphere to the Major Stratospheric Warming in 2003/2004

Dr. Dora Pancheva
Electronic & Electrical Engineering University of Bath IAGA

Plamen Mukhtarov, Borislav Andonov

The sudden stratospheric warming (SSW) is a transient large-scale thermodynamical event which involves coupling between the lower, middle and upper atmosphere. It is caused by the interaction of the atmospheric circulation with planetary waves (particularly quasi-stationary planetary waves) originating predominantly in the lower atmosphere. The present study is focused on the vertical and latitudinal coupling due to travelling and stationary planetary waves observed in the middle atmosphere during the winter of 2003/2004. The emphasis is on the major SSW beginning in early January 2004 and led to nearly two months of vortex disruption. The UK Met Office data have been used to identify the planetary waves in the Northern Hemisphere up to altitudes of ~52 km. A clear evidence of zonally symmetric planetary waves with very large amplitudes particularly in the upper stratosphere have been found in the UK Met Office zonal wind data. The wave amplitudes indicate the presence of two latitudinal ranges of amplifications centred at 50-60oN and 20-30oN and the waves from both ranges are almost out of phase. These waves play a significant role in the coupling of high- and low-latitude regions. The planetary waves in the mesosphere-lower thermosphere (MLT) have been determined by MF and meteor radar neutral wind measurements. These radars are located at two latitudinal ranges: (i) a high-latitude range of 55-70oN, and (ii) a tropical range of 20-30oN. The planetary wave responses of the MLT dynamics to the major SSW in the winter of 2003/2004 at both latitudinal ranges have been studied in detail.

Keywords: tropical mesosphere, stratospheric warming, latitudinal coupling

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

JAS009 **Oral Presentation** **530**

Relation between equatorial zonal electric field and F region electron density distribution

Dr. Claudia Stolle
Section 2.3 GeoForschungsZentrum Potsdam IAGA

Manoj, C., Lhr, H., Maus, S., Alken, P.

The Equatorial Ionization Anomaly (EIA) is a typical phenomenon of the day side F region ionosphere at low latitudes. The formation of the EIA results from the diurnal variation of the zonal electric field which is governed by E-layer dynamo action during daytime. A positive correlation between the electron density distribution in the F region and the E-layer electric field has been documented in the literature. The CHAMP satellite carries a Langmuir Probe taking in situ electron density samples every 15s. For each orbit a latitudinal profile of electron density is available at the satellite height. These profiles provide information about the spatial structure of the EIA. After normalizing the electron density readings to a common altitude of 400km the global maxima at the northern and southern hemisphere crests and the trough at the equator are identified. We correlate the crest-to-trough ratio, the L-values of the crests, crest minus trough and the crest magnitudes with the vertical plasma drift data obtained from 150km-echoes of the JULIA radar in Peru. In addition the electron density observations are correlated with the local equatorial electrojet (EEJ) strength.The reasonably long common data set covers the period from 2001 to 2005. The almost continuous availability of plasma drift observations enables us to investigate the degree of correlation for various time delays. Highest correlation coefficients are found for drift data preceding the electron density observations by ~2hrs. The correlation increases towards the afternoon compared to morning or noon hours. We observe even higher correlation coefficients when using EEJ observations instead of the vertical plasma drifts. The considered period from 2001 to 2005 spans almost the time from solar maximum to solar minimum. The different parameters, plasma density/distribution, vertical plasma drift and EEJ strength show different dependences on solar EUV radiation. In this respect, the latter two quantities are related through the E-layer conductivity. Furthermore, we check the dependence of the correlation between E-field and F region electron density on EUV flux level.

Keywords: equatorial ionosphere, ionisation anomaly, electrojet

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

JAS009 **Oral Presentation** **531**

Equatorial spread F and sporadic E layer connection during the conjugate point experiment (COPEX) in Brazil

Dr. Inez Batista
Aeronomy Divisio National Institute for Space Research IAGA

M. A. Abdu, B. W. Reinisch

The Conjugate Point Equatorial Experiment (COPEX) was conducted in Brazil from October 1 to December 9, 2002. The configuration of the experiment was planned in such a way that the observational instruments should be located at three sites nearly along a magnetic meridian, one at the magnetic equator and the other two at magnetically conjugate points. The magnetic conjugate points were selected such that the conjugate E layers were field line mapped close to the F layer peak over the magnetic equator. The three locations were Campo Grande (CG, 20.5 S, 54.7 W, southern conjugate point), Boa Vista (BV, 2.8 N, 60.7 W, northern conjugate point) and Cachimbo (CA, 9.5 S, 54.8 W, near the magnetic equatorial point). Three Digital Portable Sounders (DPS-4) were operated at 5 min. sounding interval providing 54 days of simultaneous data at the three locations. These data were analyzed to study the spread F (SF) and sporadic E (Es) layers characteristics. The occurrence frequency, duration and intensity of the spread F increased from October to December. The SF onset time at CA varied from 2200 to 2340 UT with a median value of 2230 UT. The mean time lag between SF onset times at the magnetic equator and at the two conjugate stations was of the order of 30 min. The Es layer was studied through the parameters foEs and fbEs (the Es layer critical and blanketing frequencies, respectively). The analysis ofthese Es layer parameters showed more intense Es activity over BV than over CG. At both locations fbEs generally presents a diurnal maximum with its occurrence time varying between 13 and 21 UT and very low occurrence at both conjugate locations between 00 and 09 UT. The present study does not detect any significant correlation between the SF occurrence/generation at the magnetic equator and sporadic E layer at the conjugate E regions along the same field line. The integrated field line conductivity is not significantly affected by the occurrence of Es at the conjugate E regions and its presence is not sufficient to inhibit the vertical drift and spread F generation at the magnetic equator. The observed results are interpreted at the light of the existing theories of the electrodinamical coupling of E and F regions at equatorial and low latitudes.

Keywords: spread f, sporadic e, equatorial ionosphere

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

JAS009 **Oral Presentation** **532**

Evolution of spatial structure in equatorial plasma bubbles generated due to magnetospheric forcing

Prof. Archana Bhattacharyya

Indian Institute of Geomagnetism Indian Institute of Geomagnetism IAGA

B. Kakad, D. Tiwari

Spaced receiver observations of ionospheric scintillations produced by the scattering oftransionospheric VHF radio waves by nighttime equatorial ionospheric irregularities, have been used in recent times to identify equatorial plasma bubbles (EPBs) generated specifically when the nighttime F-region zonal electric field reverses from westward to eastward in response to magnetospheric forcing. The spaced receiver scintillation observations have also been used to study the evolution of spatial structure in the irregularities due to the growth of the Rayleigh-Taylor instability. Spatial and temporal characteristics of the disturbance in the equatorial F-region zonal electric field produced by magnetic activity is expected to be influenced by the background plasma distribution, and both these factors play a role in the evolution of spatial structure in EPBs generated due to magnetospheric forcing. These issues are discussed here on the basis of ionospheric scintillation and ionosonde data recorded in the equatorial region.

Keywords: equatorial, plasma, bubbles

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

JAS009 **Oral Presentation** **533**

Equatorial middle atmosphere - ionosphere coupling through the Kelvin waves

Prof. Hisao Takahashi
Aeronomy Instituto Nacional de Pesquisas Espaciais IAGA

C. M. Wrasse, D. Gobbi, D. Pancheva, M. A. Abdu, I. S. Batista, L. M. Lima, P. P. Batista, B. R. Clemesha, N. J. Schuch, K. Shiokawa, J. Fechine, M. G. Mlynczak, J. M. Russell

In the South American equatorial region, at Fortaleza (3.9S, 38.4W), we observed 3-4-day periodic oscillations in the ionospheric h'F and foF2, in March and July, 2005. During the same periods meteor radar wind measurement at Cariri (7.4S, 36.5W) also showed a similar oscillation. Comparing with the other wind measurements from the different latitude and longitude, and also with TIMED/SABER satellite temperature measurements, we concluded that the 3-4 day oscillation was caused by the Ultra Fast Kelvin (UFK) wave. In this talk, we willpresent signatures of the UFK wave propagating upwards from stratosphere to mesosphere and to ionosphere. Presence of the Kelvin wave in the ionosphere has been predicted by Forbes (JASTP, 62, 1603-1621, 2001), but has not been observed yet. The 3-4-day waves might modulate the post-sunset ExB uplifting of the base of the F-layer via the induced lower thermosphere zonal wind and/or the E-region conductivity. Therefore this could have important roles in the initiation of equatorial spread F (plasma bubble).

Keywords: ionosphere, middle atmosphere, kelvin waves

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

JAS009 **Oral Presentation** **534**

Longitude/ local time dependent ionospheric responses to the October 2003 super storm over equatorial and low latitudes.

Dr. Mangalathayil Abdu
Aeronomy Division Instituto Nacional de Pesquisas Espaciais -INPE IAGA

Takashi Maruyama, Inez Staciarini Batista, Susumo Saito, Maho Nakamura

Ionospheric responses to the major magnetic storm disturbances of October 2003 are investigated using data base selected in the Brazilian and Japanese-Asian longitude sectors. Data obtained from latitudinally spaced digisondes in the equatorial and low latitude sites in and from the Asian and Japanese ionosonde network, and magnetometer data from the Pacific equatorial electrojet stations are analyzed during the period October 28-31. Prompt penetrating (PP) dawn-dusk polar cap electric fields produce large F region plasma uplift on the day- and evening- sides while the associated westward electric field on the night side produces large downdraft of the F region plasma, and causes development of westward electrojet current, observed for the first time. Episodes of PP electric field effects appear to be of larger intensity over than over Asian longitudes. Equatorial anomaly (EIA), development due to under-shielding as well as over-shielding electric fields was observed in the Brazilian and in the Asian sectors. Disturbance dynamo electric field cause large nighttime F layer uplifts that appear to be modulated by strong meridional winds in both sectors. The disturbance electric field local time variation patterns are compared with the results of recent global model (MTIGCM) simulation by Richmond et al. (2003). Transients of trans-equatorial winds, flipping direction from southward to northward, in the widely separated longitude sectors, were diagnosed to be present towards the final recovery phase of the storm. These results are presented and discussed in this paper.

Keywords: superstorm, equatorialionosphere, electricfields

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

JAS009 **Oral Presentation** **535**

Characterizing the Mesospheric Gravity Wave Field Near the Magnetic Equator, Brazil, During the Occurrence of Spread F

Dr. Michael Taylor
Center for Atmospheric and Space Sciences Utah State University IAGA

P.-D. Pautet, S. Vadas, D. C. Fritts, A. F. Medeiros, R. Buriti, J. Fechine, H. Takahashi, P. Batista, F. Sao Sabbas

Equatorial Spread F is a well documented phenomenon that can seriously disrupt satellite communications and affect GPS navigation in an as yet unpredictable manner. To help investigate the role of gravity waves in the seeding of Spread F, a multi-instrument radar, optical, and modeling campaign was conducted from during the period 22 September-8 November, 2005 (supported in part by the NASA Living With a Star program). As part of this program two multi-wavelength, all-sky CCD imagers were operated from two sites, both ~10 south of the magnetic equator, to characterize the mesospheric gravity wave field over a long baseline (~1400 km) during the occurrence of Spread F. Coincident measurements were made from a field site at Sao Joao dAlianca (14.8 S, 47.6 W, Mag. 10 S) operated by Utah State University, and Sao Joao do Cariri (7.4 S, 36.5 W, Mag. 9 S) operated by Universiade Federal de Paraiba / INPE. In addition to measurements of mesospheric OH and OI (557.5 nm) gravity wave structure, simultaneous measurements were also made of the OI(630 nm) emission to monitor the evolution of equatorial ionospheric bubbles associated with Spread F events, as measured by the radars. Copious observations of short-period, as well as several longer period, much larger-scale gravity wave events were made during this campaign which extended over two new-moon periods. This paper focuses on the propagation characteristics of the waves observed at mesospheric heights from both sites, and utilizes ray tracing to investigate the potential of several events long wavelength events to propagate to higher F-region altitudes and to identify their potential convective sources.

Keywords: airglow, imaging, equatorial

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

JAS009 **Oral Presentation** **536**

Observations and model calculations of the F3 layer in Southeast Asia

Mr. Jyunpei Uemoto
geophysics Tohoku University

Takayuki Ono, Takashi Maruyama, Susumu Saito, Masahide Iizima, Atsushi Kumamoto

The occurrence probability, local time, solar and magnetic activity dependences of the F3 layer have been clarified experimentally from ionosonde observations as well as model calculation, whereas some unexplained problems have remained. It has been reported that the F3 layer was frequently observed in June solstice season at Fortaleza (geographic latitude -4 deg, geographic longitude 322 deg, and magnetic latitude -5.4 deg), although in this season (local winter season), frequently occurrences of the F3 layer were not predicted from the model calculation with normal values of the E x B drift and meridional neutral wind and seasonal dependence of occurrences at Waltair (17.7 deg, 83.3 deg, 11.5 deg) shows a different tendency from that at Fortaleza. The latter problem could be explained by the magnetic latitudinal dependences of the F3 layer. However, the magnetic latitudinal dependences were not examined in detail, since earlier observational studies of the F3 layer have been performed using a single ionosonde data due to the lack of the ionosndes in the equatorial region. In order to clarify the mechanism of the F3 layer, we are analyzing the ionosonde data of the South East Asian Low-latitude IOnosonde Network (SEALION) mainly provided by NICT. The ionograms observed at Chiang Mai (CMU; 18.8 deg, 98.9 deg, 13.0 deg), Chumphon (CPN; 10.7 deg, 99.4 deg, 3.3 deg) and Kototabang (KTB; -0.2 deg, 100.3 deg, -10.0 deg) are used in this study. To date, it has been clarified from our data analysis that the F3 layer shows clear magnetic latitude dependences, and it was suggested that plasma diffusion along the magnetic field lines could play an important roll for generation of the F3 layer in the magnetic low-latitude region. This process does not seem to be incorporated into the concept of mechanism of the F3 layer, although it is expected that the plasma diffusion process has already been included in the earlier model calculation. In this paper, we report the results of comparison between the SEALION data, model calculations and also latitudinal plasma density structure observed from CHAMP on 10 April 2005. On 10 April 2005, the F3 layer was observed at 3 stations, although the F3 layer observed at CPN was very weak compared with that at CMU and KTB. The F3 layer at CPN started to form at 0845 LT and moved upward with shorter duration time, while at CMU and KTB, it started to form at 1000 LT and 0915 LT, respectively, and the cusp stayed close to the same altitude with longer duration time. On the other hand, the critical frequency in the magnetic CMU and KTB became higher than that CPN around 0930 LT. It means that plasma diffusion along the magnetic field lines associated with the equatorial anomaly started at least before 0930 LT. Moreover, it was found by comparing the plasma density structure observed from CHAMP with the vertical structures of plasma density that the F3 layer over CMU and KTB were located on the magnetic field lines passing through the crest of the equatorial anomaly. The F3 layer is then inferred to be associated with the equatorial anomaly, in other words, plasma diffusion along the magnetic field lines. As a result of model calculations using the SAMI2 code, the observed features of the F3 layer were basically reproduced using the normal values of the E x B drift and neutral wind for the day of 10 April 2005, although the F3 layer was not reproduced over CPN. It was found from the spatial variation of electron flux that plasma were transported from near the magnetic equator into the region of the F3 peak in the magnetic low-latitude region. These model calculation results are consistent with those found from our data analysis. It is then concluded that plasma diffusion along the magnetic field lines plays an important role for generation of the F3 layer in the magnetic low-latitude region.

Keywords: ionosonde, f3 layer

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

JAS009 **Oral Presentation** **537**

Coupling Processes in the Equatorial Atmosphere (CPEA)

Prof. Shoichiro Fukao
RISH Kyoto University IAGA

The western Pacific region called the Indonesian Archipelago is one of the centers of intense atmospheric motions and changes. The mechanisms of these atmospheric motions and changes, however, have not yet been made clear due to the sparseness of observational data in that region. The Coupling Processes in the Equatorial Atmosphere (CPEA), a six-year research project of from September 2001 to March 2007, was conducted to observationally elucidate dynamical and electrodynamical coupling processes occurring in the equatorial atmosphere. After six years of endeavor, a new Equatorial Observatory has been established for equatorial atmosphere research with the Equatorial Atmosphere Radar (EAR) as the core facility in Kototabang, West Sumatra, Indonesia (0.20S, 100.32E). The Observatory has been successfully operated in close corporation with the National Institute of Aeronautics and Space (LAPAN) of since March 2001. Various instruments have been assembled at and around the observatory to cover as wide height range as possible, including X-band meteorological radars, meteor radar, and FM-CW ionosonde, MF radars, Rayleigh/Mie lidar. Two extensive observation campaigns of CPEA were conducted, one from March to May 2004 (CPEA-I) and the other from November to December 2005 (CPEA-II). Numerous radiosondes were launched from four sites in and from three additional sites in and during CPEA-I and -II. In the present talk we will review some highlights from the campaigns: First, clear correlation between the deep convection and enhanced inertia gravity wave activity was found. The wave source for period ranging from 2 to 3 days and vertical wavelength less than 3-5 km was related to the slowly eastward advecting tropospheric convection, while no wave activity was noticed for stationary convection. Secondly, Kelvin waves with periods 10-12 days near the tropopause and 5.5-8 days in the lower stratosphere that were found over were consistent with a global feature observed by CHAMP-GPS. The Kelvin wave with higher wave number was observed by EAR to be broken at the tropopause over . Thirdly, several pieces of evidence have been provided to demonstrate that long-term variability in the troposphere influences the dynamics of the mesopause-homopause region. Finally, growth rate of plasma bubbles associated with equatorial spread F has been first estimated by direct observations by EAR. It has been suggested that gravity waves near 100 km in altitude will contribute to generation of the bubbles.

Keywords: vertical coupling, gravity waves, spread f

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

JAS009 **Oral Presentation** **538**

Planetary wave coupling of equatorial atmosphere-ionosphere system: recent results

Dr. Subramanian Gurubaran
Indian Institute of Geomagnetism Indian Institute of Geomagnetism IAGA

S. Sathishkumar, R. Dhanya

The low latitude middle and upper atmospheric regions are characterized by a variety of large-scale geophysical processes that are linked to the smallness of the Coriolis force (for processes occurring in the middle atmosphere) and the geomagnetic field configuration. In the southern Asian region, the geomagnetic equator lies at low geographic latitudes (~8.5oN) in the northern hemisphere. The medium frequency (MF) radar at Tirunelveli (8.7oN, 77.8oE) has been operating for more than fourteen years and has been offering excellent opportunities to undertake studies related to the dynamical and electrodynamical coupling of mesospheric and lower ionospheric regions in the equatorial region. Such studies have used the ground geomagnetometer measurements as complementary data. The present work focuses on planetary-scale waves observed over Tirunelveli at upper mesospheric heights and their possible influence on the quiet-time ionospheric variability as reflected in the ground geomagnetic field measurements. The large-scale atmospheric waves propagating from below are expected to participate in the dynamo action to set up large-scale electric fields and currents in the lower ionospheric region. The dominant planetary waves observed over Tirunelveli are the 6-day, quasi-2-day, 4-day and 5-day waves. The long-term data base on mesospheric winds over Tirunelveli has enabled a detailed study on the characteristics and seasonal and long-term variabilities of these planetary waves. The work reported herein examines the similarities in the variabilities of these waves observed at ~86 km and the variabilities in the strength of the ionospheric current system (primarily, the equatorial electrojet) classified in time scales similar to those of planetary waves. The results will be discussed in the context of our current knowledge on the planetary wave characteristics and those dynamical coupling processes that influence the large-scale ionospheric variability.

Keywords: waves, ionosphere, atmosphere

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

JAS009 **Oral Presentation** **539**

Zonal variations in the prereversal enhancement and equatorial spread F occurrences

Dr. Susumu Saito
IAGA

Takashi Maruyama

Ionospheric height variations associated with the prereversal enhancement (PRE) at two zonally separated ionosonde stations along the magnetic equator, Chumphon (Thailand, 10.7N, 99.4E), and Bac Lieu (Vietnam, 9.3N, 105.7E), were studied. Variations in virtual heights of the bottomside of the F-region (h'F) at 2.5 MHz observed at these two stations were analyzed for periods in March-April and September-October 2006. When the equatorial spread F (ESF) was not observed, h'F variations at the two stations were very similar. However, they are often significantly different, when ESF was observed. Our results show that longitudinal structure with a scale size of several hundred kilometer exist in the ionosphere, when ESF is generated. This scale size is much smaller than that of PRE which is 2000-3000 km. Zonal structuring of the bottom side ionosphere with several hundred kilometer appear to be closely related to ESF occurrence.

Keywords: equatorial spread f, zonal structure, ionosonde

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

JAS009 **Oral Presentation** **540**

Investigating the Ionospheric Bubble Structures Observed Simultaneously from two Sites over Brazil

Dr. Pierre-Dominique Pautet
Physics Utah State University IAGA

Michael J. Taylor, Hisao Takahashi, Eurico Rodrigues De Paula, Jos Humberto Andrade Sobral, Fernanda De Sao Sabbas Tavares, Amauri Fragoso De Medeiros, Farzad Kamalabadi, David C. Fritts

From September to November 2005, the NASA Living with a Star program supported the Spread-F Experiment campaign (SFX) in to study the effects of gravity waves on the ionosphere and particularly their role in the seeding of Rayleigh-Taylor instabilities, strong equatorial spread-F and plasma bubbles. Several US and Brazilian institutes involved in this project deployed a broad range of instruments (all-sky imagers, digisondes, photometers, meteor/VHF radars, GPS receivers) to cover a large area of Brazil. The campaign was divided in two observational phases centered on the September and October new moon periods. During these periods, the USU all-sky CCD imager operated at Sao Joao d'Alianca (14.8S, 47.6W) and the Brazilian imager located at Cariri (7S, 36W) observed simultaneously the evolution of the thermospheric bubbles in the 630nm emission. The two sites have approximately the same magnetic latitude and are separated by ~1500km. This talk will summarize the results obtained during 8 nights of coincident observations. The growing of the bubbles after sunset and their evolution during the night will be described. Strong differences appeared between the two sites and during consecutive nights. Measurements of the characteristics of the structures (size, wavelength, phase speed) will also be discussed and compared with the measurements made by the Sao Luis coherent radar and the GUVI instrument onboard of the TIMED satellite.

Keywords: ionosphere, spread f, ccd

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

JAS009 **Oral Presentation** **541**

Unusual ionospheric effects observed in the brazilian sector during the October 2003 solar flare

Dr. Fabio Becker-Guedes
Physics and Astronomy Universidade do Vale do Paraiba (UNIVAP) IAGA

Yogeshwar Sahai, Paulo Roberto Fagundes, Washington L. C. Lima, Alessandro Jose De Abreu, Valdir G. Pillat

The 28 October 2003 solar flare was one of the most intense solar flares observed in the recent past. In the present investigation we show the ionospheric effects observed in the Brazilian sector during this solar flare, using both the ionospheric sounding observations obtained at the UNIVAP stations: Palmas (10.3S, 48.3W, dip lat. 5.5S) and Sao Jose dos Campos (23.2S, 45.9W, dip lat. 17.6S), Brazil; and ground-based global positioning system (GPS) data obtained at the Instituto Brasileiro de Geografia e Estatstica (IBGE) stations: Imperatriz (5.5S, 47.5W, dip lat. 2.9S), Brasilia (15.9S, 47.9W, dip lat. 11.7S), Presidente Prudente (22.3S, 51.4W, dip lat. 14.9S), and Porto Alegre (30.1S, 51.1W, dip lat. 20.7 S), Brazil; on two consecutive days, viz., 27 (without solar flare) and 28 (with solar flare) October 2003. It should be mentioned that while the total electron content (TEC) from the GPS observations obtained during the solar flare showed an unusual short-period increase in the TEC values, no ionograms where obtained at any of the two UNIVAP stations for a period of about 5 hours, with start coinciding with the solar flare onset. During intense solar flares, extreme ultraviolet radiation can penetrate further into ionosphere causing increase of ionization in the lower part of ionosphere. In this way, the lack of ionograms, which indicates no echoes of the transmitted digital ionosonde signals, are related to intense absorption resulting in complete fade-out of radio signals at the lower ionospheric heights where collisional frequency is large.

Keywords: solar flare, ionosonde, gps

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

JAS009 **Oral Presentation** **542**

Equatorial Spread F and Coupled Low-Latitude Ionosphere Studied by the Equatorial Atmosphere Radar

Dr. Tatsuhiro Yokoyama
Earth and Atmospheric Sciences Cornell University IAGA

Shoichiro Fukao

Equatorial spread F (ESF) is one of the long-standing challenging subjects that strongly intrigue many researchers. Since Jicamarca VHF radar in Peru first detected topside radar backscatter plumes that cannot be produced by the linear Rayleigh-Taylor instability, the Jicamarca radar has been the most powerful tool for observation of ESF. The recent improvement of Jicamarca radar has made it possible to resolve small-scale structures within an illuminated volume using an imaging technique. On the other hand, because of its slit camera-like illumination, it has not been possible to distinguish between spatial and temporal variations in a range-time-intensity format of plumes. The question when and where ESF is initiated and intensified has been remained for a long time. The Equatorial Atmosphere Radar (EAR), which has the active phased-array antenna system, makes it possible to steer the radar beam as much as 50 in azimuth on the plane perpendicular to the geomagnetic field lines. EAR can take a snapshot of backscatter plumes with zonal and altitude distances of several hundred kilometers within a few minutes. Since the first operation of EAR in 2001, many important aspects, for example, onset, growth and spatial distribution of backscatter plumes, have been revealed with EAR. The unique location of EAR at a dip latitude of 10.36S is also capable of studying the electrodynamical coupling because the E region illuminated by EAR is connected with the F region over the dip equator with the geomagnetic field line. The E-region irregularities observed with EAR are disrupted during the growth phase of a plume simultaneously observed in the F region. The irregularities observed in the valley region have similar horizontal structure to that of F-region plumes. Another interesting result is simultaneous observation of plasma blobs with a satellite and backscatter plume with EAR on a common flux tube. While the ROCSAT-1 detected plasma density enhancements in the northern hemisphere, backscatter plumes observed by the EAR rapidly grew in the pre-midnight sector under the magnetically quiet condition. These results suggest importance of studying equatorial ionosphere as a fully coupled system, that is, from equatorial to low latitudes, and from lower to upper ionosphere.

Keywords: spread f, plasma bubble, ear

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

JAS009 **Oral Presentation** **543**

Attenuation of GPS scintillations during the 2003 Halloween Storm, at Natal, Brazil

Prof. Enivaldo Bonelli
Fsica Federal University of RN, Brazil

Flavio Enrique Costa

One of the strongest recent magnetic storms was the one of October 2003, also known as the Halloween Storm. The community of space geophysicists usually take it for granted that magnetic storms cause perturbations in the ionosphere in a way as to increase the intensity of amplitude scintillations in radio signals from satellites. This was not the case for the GPS observatory at Natal, Brazil (5.84 S, 35.20 W, -21.8 declination, -21.6 dip,) where the storm caused the scintillations to almost vanish, during the three storm days. Other main strong storms from 2003 through 2005 had the same attenuating effect. In this paper, however we concentrate on the discussion of the Halloween Storm. The method used is helpful for forecasting purposes: we compute the sum of hourly Kp index from midnight through 1800 LT. Then, based on this sum, one can estimate that scintillations will be very few for that night, if the sum(Kp)>30. In another analysis, we plot an hourly S4 scintillation index versus time and compare its behavior with respect to the hourly Dst, to verify the theory that scintillations are either enhanced or quenched, depending on the phase of the storm. This analysis is complicated by the superposition of storms.

Keywords: gps scintillations, ionospheric scintillations, equatorial ionosphere

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

JAS009 **Oral Presentation** **544**

Ultra-multi-channel and multi-static meteor radar observation of horizontal distribution of wind veolcities with the MU radar and cooparative optical observations

Dr. Takuji Nakamura
Research Instiitute for Sustainable Humanosphere Kyoto Univ. IAGA

Masaki Tsutsumi, Takuyad. Kawahara, Kazuo Shiokawa

The MU radar meteor echo observation with 1 MW transmission powerhas been used to derive precise horizontal wind velocities in the MLT region (80 - 100 km).Relative temperature fluctuation can also be derived usingambipolar diffusion coefficient measured by decay timeconstants of meteor echoes. A new receiving system with a 29 digital quadrature detection at 5 MHz intermittent frequency (IF)signal was attached to the MU radar in 2004. This ultra-multi-channelreceiver system enables to carry out imaging observation in bothfrequency domain and statial domain for studying small-scalestructures such as turbulent scattring layers in the tropospehereand stratosphere, field-aligned irregularities in the ionosphere etc.We have applied the new MU radar system for meteor echoobservation. Coherently integrated 25 channel receiving signalsimproved the SNR of meteor echoes significantly, and meteor echo number became as large as 50,000 per a day, which is about five times of previous meteor observations with the MU radar.The high-rate meteor echoes were utilized to detect horizontaldistribution of wind velocity field of about 50 km scale.It is first confirmed that the wind velocities determined witha smaller area was much larger than the winds estimated forall FOV (field-of-view) of about 300-400 km diameter. The wind field distribution and its time evolution showedhorizontal propagation of wave structures, such as gravity waves.The comparison with the airglow imaging has shown that similarwave structures were observed both the radar and the imager,suggesting capability of simultaneous observation of an identicalwave. A sodium temperature lidar is also operated in order toderive atmospheric stability of the background of the wave propagation. Besides the new MU radar system, external receivingsystems for measuring forward scatter of meteor echoes are beingbuilt. These receivers are synchronized using GPS signals. Sixextermal receiving sites are to be constructed within the distanceof about 60 km from the radar. The total multisatic radar systemwill clarify detailed horizontal structure of MLT region, and coupling between the middle atmosphere and the ionosphere.

Keywords: mesosphere lower thermosphere, meteor radar, horizontal structure

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

JAS009 **Oral Presentation** **545**

Reverse ray-tracing gravity waves over Brazil to identify convective source regions, modeling GW spectra from these regions, and identifying potential influences at the highest altitudes

Dr. Sharon Vadas
Colorado Research Assoc NorthWest Research Associates IAGA

C. Fritts, P.-D. Pautet, M.J. Taylor, H.-L. Liu, P. P. Batista, P. Stamus, H. Takahashi, F. Sao Sabbas, A.F. Medeiros, R. Buriti, J. Fechine

Gravity waves (GWs) were observed in airglow images over Brasilia, Brazil, during the 2005 SpreadFEx measurement program. We describe here how we reverse ray-traced these GWs to identify potential convective source regions. The wind and temperature profiles we used here were based on TIME-GCM 2005 model data, and incorporated meteor radar data at mesopause altitudes in order to correct for mean, semidiurnal and diurnal wind components, and extrapolate their amplitudes more realistically to higher altitudes. These profiles also incorporate balloon data up into the lower stratosphere. We show that reverse ray-tracing small-scale GWs observed near the mesopause can lead to ambiguous convective source identifications if the winds are not known accurately, while reverse ray-tracing larger horizontal-scale GWs can lead to more robust identifications of the convective source regions. This difference occurs because in the latter case, GW vertical group velocities are larger, and therefore less influenced by wind effects. We identify likely convective source regions for several large-scale GWs observed in the airglow images. Using our convective plume model, we then calculate the full GW spectra these source regions likely generated, and ray-trace them into the thermosphere using our 3D ray-trace model which incorporates our new, dissipative, anelastic GW dispersion relation. We then calculate the altitudinal dependence of the GW spectra from these convective source regions in the thermosphere, and estimate their potential influences on the F-region. We show that some of the GWs may have the appropriate characteristics to enable seeding plasma instabilities and equatorial spread-F.

Keywords: gravity waves, ray tracing, thermosphere

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

JAS009 **Poster presentation** **546**

Investigation of dependence of substorm effects in equatorial electrojet and parameters of F-Region of ionosphere on the separate stations from ut substorm beginning on the basis of GSM TIP

Mr. Maksim Klimenko
Kaliningrad State Technical University, Phys. Dep. Sovetskij Av., 1, Kaliningrad, 236000, Russia IAGA

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 equatorial electrojet from which the intensity time course of westward and eastward equatorial electrojet has been constructed was calculated. Calculations have shown, that during the substorms beginning in 06 UT and 18 UT, there is a reduction of intensity of the counter electrojet from - 12 A/km in quiet conditions up to - 4 A/km; during the substorms beginning in 00 UT, there is the counter electrojet easing from - 8 A/km in quiet conditions up to - 4 A/km, and during the substorms beginning in 12 UT, the counter electrojet practically does not vary. At the same time the eastward equatorial electrojet intensity during the substorms beginning in 00 UT and 12 UT decreases from ~50 A/km in quiet conditions up to ~40 A/km; during a substorm beginning in 06 UT, its intensity decreases up to ~15 A/km, and for a substorm beginning in 18 UT, it in the beginning grows up to 65 A/km, and then falls up to 40 A/km. 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 geomagnetic equator the precise semidiurnal harmonic in foF2 perturbations with maxima of positive disturbances in post-sunset and pre-sunrise hours and maxima of negative disturbances in post-midnight and near-midday hours is traced. Negative ionospheric disturbances are observed mainly at night from subauroral latitudes up to geomagnetic equator. By the moment of the substorm termination the positive disturbances in the post-sunset sector at geomagnetic equator considerably amplify. Calculation results of the foF2 temporal course during substorms are submitted and analyzed for equatorial, low- and mid-latitude stations Jicamarca, Fortaleza, Ujjain, Okinawa, Tashkent, Rome and Graz.

Keywords: ut variation, electrojet, substorm

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

JAS009 **Poster presentation** **547**

Seasonal variation of ionospheric parameters at station JICAMARCA in solar activity maximum

Dr. Vladimir Klimenko
West Department of IZMIRAN Pobedy Av., 41, Kaliningrad, 236017, Russia IAGA

Bryukhanov Valerij Veniaminovich

In the given work the results of numerical calculations on the Global Self-consistent Model of Thermosphere, Ionosphere and Protonosphere (GSM TIP) the behavior of ionospheric parameters at station Jicamarca with take into account only the dynamo-field, generated by thermospheric winds are presented. The calculations have been executed by completely self-consistent manner for quiet conditions of equinox and solstice in maximum of solar activity. It is shown, that all considered parameters of the ionosphere in spring and autumn practically do not differ from each other. The amplitude of zonal component of the electric field in a solstice is more in factor 2, than in an equinox. In summer the critical frequency of the ionospheric F2-layer is higher, and the height of F-layer maximum is lower, than during other seasons. At station Jicamarca due to stratifications of the equatorial F2-layer of the ionosphere the F3-layer is formed earlier in winter and later in summer. At height 1500 km the meridional component of the thermospheric wind forms the G-layer in equinox. In a solstice the G-layer is not present.

Keywords: ionosphere, anomaly, stratification

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

JAS009 **Poster presentation** **548**

E-Region Electric Fields at the Brazilian Dip Equator Estimated using 50 MHz Radar

Dr. Clezio De Nardin
Divisao de Aeronomia Instituto Nacional de Pesquisas Espaciais

Mangalathayil Ali Abdu, Jos Humberto Andrade Sobral, Cristiano Max Wrasse

Electric fields have been estimate at E region heights based on coherent backscatter echoes from the equatorial electrojet obtained with the RESCO backscatter coherent radar during quiet time in 2002. The technique of estimating electric fields used by Balsley (1969, JGR, 74 (A9), 2333-2347) based in determining Doppler velocity from radar echoes type 2 at low elevation angles was adapted for use at the 50 MHz radar installed at So Lus (2.3 S, 44.2 W, dip: ~ -0.5), Brazil. RESCO radar uses a 7 beam width at an elevation angle of 60 for equatorial electrojet sounding. This relatively narrow beam allows us to deduce the altitude of the scatter directly from the range. Therefore, we measure the drift profile of the electrojet, which is used as basis for zonal electric fields estimates. Curve fitting techniques was used to estimate type 2 Doppler shifts from echoes power spectra. This method was chosen due to the presence of the superimposed type 1 Doppler shift around local midday. A magnetic field aligned integrated conductivity model was used to calculate Pedersen and Hall conductivities at E region heights (Denardini, 2005, 9th CISBGf, pp. 435.1-435.4). Electron density used in this conductivity model is based in the IRI model corrected by electron densities obtained from digisonde measured of the daytime equatorial E-layer (foE) over three locations that constituted a conjugated points station pair: Campo Grande in south (20.45 S, 54.65 W, dip: -22.5) and Boa Vista in north (2.8 N, 60.66 W, dip: 22.5), and an equatorial station, Cachimbo (9.47 S, 54.83 W, dip: -3.9). Our results are presented and discussed in terms of the South hemisphere seasons and are comparable to previous ones obtained for different longitudinal sector, such as by Reddy et at. (1987, JATP, 49 (2), 183-191), who have used the same approach for estimating electric field despite the different method for estimating the Doppler velocities from the radar echoes.

Keywords: equatorialelectricfield, e region, coherentradar

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

JAS009 **Poster presentation** **549**

Disturbed time observations of the temporal dependence and dynamics of TEC, scintillation, and ionospheric irregularity zonal drifts

Mr. Marcio Muella
Divisao de Aeronomia Instituto Nacional de Pesquisas Espaciais

Eurico Rodrigues De Paula, Ivan Jelinek Kantor, Paulo Flabiano Smorigo, Alessandro Paolo Cerruti, Paul M Kintner, Inez S Batista, Cathryn N Mitchell

GPS derived total electron content (TEC), amplitude scintillations at the L1 frequency (1.575 GHz) and estimations of the ionospheric irregularity zonal drift velocities at 350 km are coupled and utilized for studying the large disturbance of the equatorial and low latitude ionosphere in the South-American longitude sector. Events of intense and moderate geomagnetic storms occurred in the current declining phase of the solar cycle were analyzed in this investigation. Using a time-dependent inversion algorithm 2-D images are created to study specific relationships between the three geophysical quantities (TEC, scintillation and zonal velocities) measured by ground-based GPS receivers. It is revealed from the 2-D images that the equatorial ionization anomaly (EIA) expanded to much higher latitudes, and the observed large variations in the temporal and spatial evolution of the electron density affected the behavior and dynamics of the irregularities. The coupling of the neutral atmosphere and the ionosphere is also investigated using neutral winds models results. The models are used to investigate the north-south symmetry/asymmetry conditions in the ionization distribution of the equatorial anomaly produced by a meridional/transequatorial wind and its effect to the development and evolution of the scintillations associated to the ionospheric irregularities. In this work we present some relevant aspects of the ionospheric dynamics and the thermosphere-ionosphere coupling system, which are some of the most important topics of study during the occurrence of geomagnetic storms.

Keywords: f region, scintillations, gps

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

JAS009 **Poster presentation** **550**

Ionospheric scintillations in the pre-sunrise hours over the Brazilian tropical region as observed by ground-based GPS receivers

Mr. Marcio Muella
Divisao de Aeronomia Instituto Nacional de Pesquisas Espaciais

Eurico Rodrigues De Paula, Ivan Jelinek Kantor, Inez S Batista, Paulo Flabiano Smorigo, Cathryn N Mithell

We report in this paper pre-sunrise (secondary) observation of ionospheric scintillations in the tropical ionosphere over Brazil. We present observational evidence from a network of ground-based GPS receivers and digital ionosondes. Our observations reveal that these pre-sunrise scintillations are mostly correlated to enhancements in the eastward electric fields due to the prompt penetration magnetospheric and ionospheric disturbance dynamo electric fields. In addition, we investigate other features associated to the post-midnight/pre-sunrise occurrence of scintillations, such as equatorial F region uplifts and possible changes in the horizontal neutral winds and in the irregularity zonal drift velocities. Finally, we use a time-dependent inversion algorithm in order to study specific relationships between TEC, electron density and the occurrence of the pre-sunrise scintillations.

Keywords: gps, irregularities, radiotomography

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

JAS009 **Poster presentation** **551**

Longitudinal distribution and statistics of the He+ density depletions (bubbles): Northern and Southern Hemispheres

Dr. Larissa Sidorova
IZMIRAN Russian Academy of Science IAGA

Sergey Vitalvich Filippov

He+ density depletion (bubble) occurrence probability with respect to longitude is considered for the post-sunset hours under winter, summer and equinoctial conditions in the Northern and Southern hemispheres. Study based on the ISS-b satellite observations, obtained during a high solar activity period 1978-79 (F10.7~200) in the topside ionosphere (~1100 km). It was found that the He+ density depletion statistics is more significant in winter than in summer for the both hemispheres. The statistics, obtained in the different hemispheres, differs in the amplitude behavior. The map of the He+ density depletion (bubble) distribution as function of latitude-longitude for the post-sunset hours was also derived. This map was compared with the similar map for ESF and plasma bubble distribution, obtained by Maruyama and Matuura (1984) on the basis of the ISS-b observations. It was revealed that there is a good conformity in spatial distributions of these phenomena. The obtained results, indicated the strong asymmetry between the Northern and Southern hemisphere and seasonal dependence, are discussed.

Keywords: he density depletions, longitudinal statistics, longitudinal disrtibution

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

JAS009 **Poster presentation** **552**

Analysis of Ray-like structures in equatorial plasma bubbles using OI 777.4 nm Emission

Mrs. Claudia Candido
CEA INPE IAGA

Jose Ricardo Abalde Guede, Yogeshwar Sahai, Valdir Gil Pillat

The optical emissions originating in the upper atmosphere (OI 557.7 nm, OI 630.0 nm and OI 777.4 nm) have been used in the last decades to study disturbances in the thermosphere-ionosphere system, dynamics and the morphology of equatorial plasma bubbles. The plasma bubbles are large-scale structures associated with equatorial range Spread-F, which have been extensively studied because of their spurious effects on the satellite based telecommunication and navigation systems. These large-scale plasma structures are low density plasma regions (about three orders of magnitude lower than the ambient plasma density), and quasi north-south geomagnetic field aligned. Also, plasma bubbles usually drift eastward with velocities between 50 m/s to 150 m/s and their frequency of occurrence depends on season and solar cycle. Recent observations by Abalde et al. (JGR, 106(A12), 2001) from a low latitude site, using OI 777.4 nm emission all-sky imaging, showed that plasma bubbles have well defined borders with ray-like structures inside. The zonal extension of the plasma bubble is few tens kilometers. These ray-like structures were not reveled by the OI 630.0 nm emission wide-angle imaging because the lifetime of the oxygen atom excited state (O 1D) from which originates the OI 630.0 nm emission is fairly long (~110 seconds) compared with lifetime (microseconds) of the oxygen atom excited state (O 5P) responsible for the OI 777.4 nm emission. The present work shows that plasma bubbles in OI 777.4 nm emission have zonal width varying from 30 to 150 km. It is also observed that plasma bubbles have several ray-like structures (3 to 7) and the zonal widths of these structures vary from 6 to 40 km. The number and widths of these ray-like structures depend on zonal width of the plasma bubble. These ray-like structures are possible associated with secondary ionospheric instability process inside of the plasma bubble.

Keywords: plasma bubbles, ionospheric irregularities, airglow imaging

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

JAS009 **Poster presentation** **553**

Local linear growth rate of collisional Rayleigh-Taylor instability under geomagnetic disturbed conditions during solar maximum

Dr. Lee Chien-Chih
General Education Center, Ching-Yun University General Education Center, Ching-Yun University IAGA

This study chooses 5 cases under geomagnetic disturbed conditions to investigate the effects of geomagnetic disturbance on local linear growth rate (γ) of collisional Rayleigh-Taylor (CR-T) instability. On case at 30 July 1999, the γ value at 1900 LT is larger than the associated monthly averages under quiet-conditions of April and October 1999. Since the occurrences of equatorial spread F (ESF) are higher in April and October, the ESF is generated in the sunset period. In contrast, at 12 and 22 September 1999, the γ value at 1900 LT is smaller than the associated quiet-conditions monthly averages of June 1999, in which the ESF occurrence is lower. Thus, the ESF does not occur in these two days. In addition, the growth rates in the cases of 26 September and 31 December 1999 are not affected by the geomagnetic disturbances. The ESF appear in these two days, because of the higher ESF occurrences in September and December. These results show that the case-by-case variability exists in the responses of geomagnetic disturbance to growth rate.

Keywords: equatorialionosphere, growthrate

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

JAS009 **Poster presentation** **554**

Scale Analysis of Pre- and Post-Midnight ESF Bubbles at Storm Time and Quiet Time

Dr. Kang-Ying Chen
IAGA

S. Y. Su, H. C. Yeh, C. H. Liu

This paper adopts a scale analysis technique to investigate the properties of intermediate scale plasma structures observed by ROCSAT-1 in the equatorial F region. A procedure of scale analysis that developed via the empirical mode decomposition (EMD) method of Hilbert-Huang transform (HHT) technique allows the mutually correlated components in velocity, density and relative density gradient to be identified and extracted. Comparing the three parameters, good match in wave form is found for density and velocity in scales between kilometers and hundred meters (few kilometers ~ 300 m). It implies that there are electric fields proportional to density fluctuation in the form similar to what expected for the generalized Rayleigh Taylor instability. We find such a one-to-one match holds for various pre- and post-midnight ESF bubbles at storm time and quiet time. It therefore means that spatial structures of electric field in the intermediate scale (few kilometers ~300m) will correlate to the density structures in a manner of not necessary depending on the driving mechanism of ESF bubbles, although it is known that ESF bubbles can be driven by different mechanisms under different space weather conditions. In smaller scales (300 m ~ 50m), fluctuation patterns of density and velocity dont correlate to each other any more, the good match is then found in density gradient and velocity. It is known as the manifestation of the Boltzmann relation. We note that the GRT instability related relationship for irregularities in scale of kilometers holds only for ESF bubbles occur within 5 dip latitude, while the Boltzmann relation (δVz proportional to $\delta \ln N$) holds for small scale irregularities without such a limitation.

Keywords: esf bubbles, scale analysis, hilbert huang transform

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

JAS009 **Poster presentation** **555**

Coupling processes underlying the magnetic storm-time behavior of the equatorial ionosphere

Prof. Sastri Hanumath, J
Solar-Terrestrial Physics Indian Institute of Astrophysics IAGA

The properties of the equatorial ionosphere get modified on various time scales during enhanced geomagnetic activity in general, and the different well-defined phases of magnetic storms, in particular. In this paper, I shall endeavor to review recent studies, both experimental and theoretical, of this subject and bring out the progress in our understanding of the various coupling mechanisms (high latitude-low latitude electrodynamic and dynamic coupling, plasma-neutral coupling) underlying the observed ionospheric disturbances at equatorial latitudes. The review highlights the equatorial ionospheric effects of super-geomagnetic storms that mother Nature provided us in the recent past. It also covers such topics as the equatorial manifestation of geomagnetic storm sudden commencement (ssc) and the storm-time low latitude geomagnetic field variations. The review concludes with a summary of the outstanding problems concerning the storm-time equatorial ionosphere and the possible approaches that may be followed to resolve them.

Keywords: equatorial ionosphere, magnetic storms

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

JAS009 **Poster presentation** **556**

Investigation of the equatorial MLTI region during a partial solar eclipse through ground-based daytime optical technique

Dr. Tarun Pant
Depertment of Space Indian Space Research Organisation IAGA

A study of simultaneous variations of optically measured daytime mesopause temperature and thermospheric dayglow (O1D 630.0nm) intensity during the partial solar eclipse event on October 03, 2005, has been investigated. The measurements were made using the Multiwavelength Dayglow Photometer (MWDPM) from Thumba (8.5oN, 76.5oE, 0.5oN diplat.), a geomagnetic dip equatorial station in India. This paper presents the first direct evidence of an eclipse-induced equatoward movement of the Equatorial Ionization Anomaly (EIA). The eclipse in ionosphere decreases the ionization as well as the field aligned conductivities. This in turn would reduce the strength of the fountain mechanism and enforce EIA crest to move towards equator. Further this study demonstrates the in situ generated gravity waves and consequent temperature increase in mesopause region during the eclipse. It is also proposed that the eclipse causes an increase in the ozone and atomic oxygen (O) concentration in the mesopause region that, in turn, causes an enhanced heating through the exothermic chemistry. In this context, the present study demonstrates the influence of a partial solar eclipse in an electrodynamic process i.e. EIA and neutral process (mesopause temperature), using optical method is first of its kind.

Keywords: solareclipse, mesopause, airglow

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

JAS009 **Poster presentation** **557**

High latitude low latitude coupling observed in equatorial MLTI region during Sudden Stratospheric Warming event of 2006.

Dr. Tarun Pant
Depertment of Space Indian Space Research Organisation IAGA

The present paper, for the first time, analyses the variations of daytime mesopause temperature and the Electrojet strength over equator during Sudden Stratospheric Warming (SSW) events over high latitudes. The results indicates strong dynamical coupling between the two, through the intensification of planetary wave activity. The daytime mesopause temperature is estimated using intensities of OH (8-3) Meinel band measured by means of unique dayglow Photometry, from Trivandrum (8.5oN, 76.5oE, 0.5oN diplat.), a geomagnetic dip equatorial station in India. The wave signatures (~16 days period) are seen in both the mesopause temperatures and electrojet induced surface magnetic field. This investigation reveals (i) intensification of the planetary wave activity in equatorial mesopause temperature prior to SSW (ii) occurrence of Counter Electrojet (CEJ), with periodicity ~16 days during the SSW period (iii) time shift of CEJ occurrence towards evening as the events progress and (iv) diminishing CEJ strength with amplitude of wave oscillation damping with time. These results are new and reveal some new aspects about the dynamics of MLTI region and are discussed in detail.

Keywords: sudden stratospheric warming, planetary wave mesopause, counter electrojet

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

JAS009 **Poster presentation** **558**

Study on temporal and spatial variations of the ionospheric OI 6300 emission observed at Southern Space observatory, 29 S, Brazil

Mr. Pablo Carlesso

Marcelo Barcellos Da Rosa, Cristiano Max Wrasse, Hisao Takahashi, Kazuo Makita

Ionospheric airglow OI 6300 emission has been observed at Southern Space Observatory SSO/CRS/INPE - MCT, located at So Martinho da Serra, RS, Brasil (29 S, 53 W), since 2001. A photometer to monitor the zenith intensity and an all-sky imager to observe the spatial variation of the emission were used. The observed zenith intensities showed strong seasonal variation, maxima in the equinox season (March-April and September-October) and minima in solstice (June-July and December-January). The OI 6300 intensity depletions caused by formation of the plasma bubble along the magnetic field line were detected by the imager. The depletions were observed more frequently in the period from September to March during the summer season in Southern Hemisphere. These data and results will be compared to those observed at Space Center of Cachoeira Paulista INPE/MCT, (22.7 S, 45 W).

Keywords: aeronomy, mesosphere, solar terrestrial interaction

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

JAS009 **Poster presentation** **559**

Lightning induced lower hybrid waves and associated ion heating in equatorial plasma bubbles

Dr. Malingre Michel
CETP CETPIPSL

Berthelier Jean-Jacques, Seran Elena

During the initial phase of the large magnetic storm of November, 7 to 11, 2004, equatorial plasma bubbles with a density drop of 2 to 3 orders of magnitude were detected in the pre-midnight sector on several orbits by the low-altitude DEMETER satellite. Plasma and wave measurements at high time resolution, carried out by the satellite inside these plasma depletions, revealed new and interesting ionospheric phenomena. Besides the observation of trapped coherent ELF electromagnetic waves, the most interesting feature, illustrative of the effect of small-scale plasma density irregularities, is the existence of strong lower hybrid turbulence triggered by electromagnetic whistlers originating from thunderstorm-related lightnings below the satellite in the troposphere. High-sample rate waveforms reveal that the lower hybrid turbulence evolves in solitary structures with typical duration of ~ 20 ms and electric field amplitude as high as 15 mV/m that are similar to lower hybrid solitons commonly observed along high-latitude magnetic field lines associated with the aurora. Simultaneous with the rise of lower hybrid turbulence, the plasma analyzer detected suprathermal O+ and NO+ ions ions with density 2 to 3% of the thermal plasma density and temperatures of 1.5 to 2.9 eV, or 15 to 30 times the temperature of thermal ions. These new findings provide evidence of an unexpected strong coupling between the violent tropospheric storms and the ionospheric plasma in equatorial plasma bubbles and put in evidence for the first time that plasma processes typical of the auroral upper ionosphere such as the generation of solitary structures and the associated ion heating may also occur on equatorial field lines in highly disturbed conditions. These observations lend credence to the idea that lower hybrid solitary structures are a fundamental feature of VLF whistler mode turbulence in inhomogeneous magnetized space plasmas.

Keywords: equatorial plasma bubbles, lower hybrid waves, ion heating

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

JAS009 **Poster presentation** **560**

Observation and modeling of ionospheric scintillation observed at low latitude

Dr. Abhay Kumar Singh
Department of Physics Banaras Hindu University, Varanasi, India

The F-region of the ionosphere is a fascinating part of the upper atmosphere having both academic and applied interest. The presence and movement of plasma density fluctuations in this region are studied by monitoring phase, frequency and amplitude of radio waves propagating through this region. In this paper, we summarize the results of analysis of the amplitude scintillations of very high frequency electromagnetic wave transmitted from geostationary satellite at 244/250 MHz, recorded at low latitude station Varanasi (geom. lat. 14055/ N, long. 153055/ E, L=1.07) during the period Jan.1991 to Dec.1999. The auto-correlation function and power spectra of scintillation data shows that the spectral index of irregularities lies between 2 and 9, and the irregularities mostly belong to medium scale size. In the estimation of parameters, we have used weak scattering theory and assumed the plasma density fluctuations to behave like phase changing screen model. Appropriate relations for scintillation index S4, and phase variance F, are derived and computed for different parameters of the plasma density irregularities of the ionosphere. The plasma turbulence Cs has been defined and computed for different values of plasma density fluctuations. It is observed that the scintillation index S4 and phase variance F depends on the strength of the plasma turbulence and increases with its increase. Finally the results obtained from simulation/modeling are compared and discussed with the available recent results.

Keywords: ionospheric scintillation, ionospheric irregularities, scintillation modelling

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

JAS009 **Poster presentation** **561**

Mesospheric 6-7 day planetary wave signatures in the equatorial electrojet over equatorial latitude Tirunelveli

Mr. Sathishkumar Sundararaman
Department of Science and Technology Indian Institute of Geomagnetism

S. Gurubaran

Upward transport of wave energy and momentum due to gravity, tidal and planetary waves from the lower atmosphere in the tropical region. A 6-7 day periodicity generated in the mesosphere and lower thermosphere in the equatorial region has possible influences on the lower E- region ionospheric current system at these periodicities. Vertical coupling in the equatorial latitude atmosphere-ionosphere system driven by the 6-7 day wave in the equatorial mesopause region has been investigated. The 6.5-day wave is generally a zonal wavenumber-1 westward propagating global scale disturbance with larger amplitude in zonal wind than in meridional wind. The medium frequency radar measurements of winds have been made in the altitude region of 68-98 km at Tirunelveli (8.7N, 77.8E) since November, 1992. As a lower E region ionospheric parameter, the EEJ current strengths are measured by determining the geomagnetic field strengths at the Indian EEJ and off-EEJ stations of Tirunelveli and Alibag, respectively. The 6-7 day wave event during the period from 01 April 2004 to 31 May 2004 was identified concurrent mesospheric winds and equatorial electrojet intensity variation in the equatorial latitude Tirunelveli. Extensive analysis is carried out and the results obtained will be presented.

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

JAS009 **Poster presentation** **562**

Response of the low-latitude ionosphere to strong geomagnetic storms in 2000-2005

Dr. Elvira Astafyeva
Department of Atmosphere and Ionosphere Physics Institute of Solar-Terrestrial Physics SB RAS IAGA

Geomagnetic storms represent the largest disturbances in the magnetosphere and ionosphere. The interplanetary magnetic field (IMF) is generally southward during the main phase of magnetic storms and the interplanetary electric fields can penetrate to the low-latitude ionosphere for many hours without decay. Direct penetration to equatorial latitudes of the magnetospheric electric fields and thermospheric disturbances involving winds, electric fields and composition changes produce significant alteration in the equatorial ionization anomaly (EIA) morphology and dynamics. The intensity of the EIA and the crests north-south asymmetry are controlled significantly by the meridional thermosphere wind. Thus, the EIA serves an indicator of ionosphere-thermosphere coupling at low latitudes. In this paper we analyze response of the low-latitude ionosphere to 20 strongest geomagnetic storms in 2000-2005. Ionosphere effects are studied using data of global ionosphere maps (GIM) calculated from ground-based GPS receivers and altimeter data from the Jason-1 and TOPEX/Poseidon satellites. Use of the method we proposed before (http://www.cosis.net/abstracts/COSPAR2006/00093/COSPAR2006-A-00093-1.pdf) makes it possible to obtain global and regional maps of velocities and directions of total electron content equal lines (TECEL) displacements. This provides us quantitative characteristics of the ionosphere plasma redistribution during the main phase of geomagnetic storms as well as about the rise and evolution of TEC disturbances. After the IMF turns southward and intensifies, TEC value within the EIA area increases significantly (up to 180 TEC units by equinox time and up to 120 TEC units by summer time). In a number of events we observed poleward traveling of the EIA crests and strong north-south asymmetry. The map of TECEL velocities shows that increase of TEC within the EIA takes place due to high-speed moving of the ionosphere plasma from every quarter with the apparent velocity of about 1000-2000 m/s. Besides, there are some facts that point at longitude asymmetry of the EIA response to geomagnetic storms: TEC alterations are especially pronounced over the that might be caused by close location to the South Atlantic magnetic anomaly.

Keywords: equatorial anomaly, geomagnetic storms, tec redistribution

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

JAS009 **Poster presentation** **563**

First results on imaging observations of Hydroxyl, Sodium and Oxygen mesospheric airglow from TIRUNELVELI (8.7N)

Mr. Lakshmi Narayanan Viswanathan
Department of Science and Technology, India Indian Institute of Geomagnetism

S. Gurubaran, K. Emperumal

Observations of airglow emissions provide important information about the dynamics of the region from which they emanate. Ground based optical imaging observations of equatorial mesospheric airglows are relatively less compared to those in the high latitudes. Recently, a multi-wavelength all-sky airglow imager has been installed at the equatorial site, Tirunelveli (8.7N, 77.8E; 0.7N dip latitude), . The imager is equipped with three interference filters to observe mesospheric emissions from hydroxyl radical (720-910 nm, filter with a notch around 865 nm), sodium (589.3 nm) and atomic oxygen (557.7 nm). In this paper we present the details of the imaging system and the first results from those observations made on few moonless clear sky nights during January and February months of 2007. We examine a few significant wave-like disturbances in terms of their wavelength, period, phase speed and propagation direction.

Keywords: airglow, all sky imaging

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

JAS009 **Poster presentation** **564**

Multi-beam radar investigations of large-scale wave structure and plasma bubbles in the nighttime equatorial ionosphere

Dr. Roland Tsunoda
Center for Geospace Studies SRI International IAGA

There is growing awareness that the process leading to the development of plasma bubbles in the nighttime equatorial ionosphere involves more than simple seeding by atmospheric gravity waves and a day-to-day variability in the vigor of the Rayleigh-Taylor instability. There is evidence that large-scale wave structure (LSWS) and a vertical shear in zonal plasma drift are playing important roles during and shortly after the post-sunset rise of the F layer. Given that LSWS appears to be initiated in the vicinity of the velocity-shear node, where zonal plasma drift is small, we must face the realization that sensors, as deployed today, can neither easily detect nor properly characterize LSWS. The reason is that existing sensors depend on zonal drift and temporal variations in measurements to reveal presence of LSWS. In this paper, we describe LSWS and bubble development using observations made with multi-beam radars located on Pohnpei and Christmas Island, in the central Pacific region. We show the importance of separating the contributions from LSWS and the post-sunset rise of the F layer, to local vertical plasma drift, if we hope to understand the day-to-day variability in the development of plasma bubbles. Interpretation of LSWS in terms of seeding, instability processes, and electrical coupling will be discussed. If time permits, we will also present examples of how the temporal evolution of plasma bubbles can be extracted from multiple-beam radar data.

Keywords: equatorial spread f, large scale wave structure, velocity shear

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

JAS009 **Poster presentation** **565**

Coupling Processes in the Equatorial Atmosphere (CPEA)

Prof. Shoichiro Fukao
RISH Kyoto University IAGA

The western Pacific region called the Indonesian Archipelago is one of the centers of intense atmospheric motions and changes. The mechanisms of these atmospheric motions and changes, however, have not yet been made clear due to the sparseness of observational data in that region. The Coupling Processes in the Equatorial Atmosphere (CPEA), a six-year research project of from September 2001 to March 2007, was conducted to observationally elucidate dynamical and electrodynamical coupling processes occurring in the equatorial atmosphere. After six years of endeavor, a new Equatorial Observatory has been established for equatorial atmosphere research with the Equatorial Atmosphere Radar (EAR) as the core facility in Kototabang, West Sumatra, Indonesia (0.20S, 100.32E). The Observatory has been successfully operated in close corporation with the National Institute of Aeronautics and Space (LAPAN) of since March 2001. Various instruments have been assembled at and around the observatory to cover as wide height range as possible, including X-band meteorological radars, meteor radar, and FM-CW ionosonde, MF radars, Rayleigh/Mie lidar. Two extensive observation campaigns of CPEA were conducted, one from March to May 2004 (CPEA-I) and the other from November to December 2005 (CPEA-II). Numerous radiosondes were launched from four sites in and from three additional sites in and during CPEA-I and -II. In the present talk we will review some highlights from the campaigns: First, clear correlation between the deep convection and enhanced inertia gravity wave activity was found. The wave source for period ranging from 2 to 3 days and vertical wavelength less than 3-5 km was related to the slowly eastward advecting tropospheric convection, while no wave activity was noticed for stationary convection. Secondly, Kelvin waves with periods 10-12 days near the tropopause and 5.5-8 days in the lower stratosphere that were found over were consistent with a global feature observed by CHAMP-GPS. The Kelvin wave with higher wave number was observed by EAR to be broken at the tropopause over . Thirdly, several pieces of evidence have been provided to demonstrate that long-term variability in the troposphere influences the dynamics of the mesopause-homopause region. Finally, growth rate of plasma bubbles associated with equatorial spread F has been first estimated by direct observations by EAR. It has been suggested that gravity waves near 100 km in altitude will contribute to generation of the bubbles.

Keywords: vertical coupling, gravity waves, spread f

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

JAS009 **Poster presentation** **566**

Effects of magnetic storms on GPS scintillation for solar minimum conditions at Natal, Brazil

Prof. Enivaldo Bonelli
Fsica Federal University of RN, Brazil

Ricardo Yvan De La Cruz Cueva, Gilvan Luiz Borba

GPS amplitude scintillation obtained in Natal, Brazil (5.84 S, 35.20 W, -21.8 declination, -21.6 dip) is analyzed for effects of magnetic storms on the attenuation or enhancement of scintillations, measured in terms of the S4 scintillation index. The intensity of the storms is measured both in terms of the sum of the Kp index from mid-night through 1800 hours local time (LT) and the hourly Dst index from 1500 LT through 0300 LT. The data represents the period from October 2006 through February 2007, during the present solar minimum. The results show that, for strong storms (sum(Kp) > 30) the scintillations are attenuated, as compared to non-storm days. Actually, it is possible to see a anti-correlation between storm and scintillation: when there is no storm, the scintillation increase. On the other hand it is very difficult to study the effects of the magnetic storms as represented by the Dst index, due to superposition of storms and sub-storms.

Keywords: low latitude ionosphere, ionospheric scintillations, global positioning system

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

JAS009 **Poster presentation** **567**

Equatorial spread-F occurrence observed at two near equatorial stations in the Brazilian sector in June and December solstice months during low solar activity period

Dr. Fernando Bertoni

Centro de Fsica Espacial e Atmosfrica Universidade Luterana do Brasil IAGA

Washington Luiz Carvalho Lima, Yogeshwar Sahai, Paulo Roberto Fagundes, Valdir Gil Pillat, Fbio Becker-Guedes

In this work, a study is presented regarding the occurrence features of equatorial spread-F (ESF) observed at two Brazilian near magnetic equator stations, namely, Palmas (10.2 S, 48.2 W; dip lat. 5.5 S) and Manaus (3.1 S, 60.0 W; dip lat. 6.4 N). Both stations are located in the Amazonian rainforest region on opposite sides of the magnetic equator. We have analyzed some ionospheric sounding data observed simultaneously by two digital ionosondes operating on a routine basis at the two stations during November, December 2005 and January 2006 (December solstice months) and May-July 2006 (June solstice months). The period analyzed relates to low solar activity. Range spread-F (RSF) is the most common type observed at those two locations, independent of the month of observations (pre-midnight spread-F is by far the most common feature observed at both stations). However, during the June solstice months, ESF is observed with less frequency at both stations. The salient features from these simultaneous ionospheric sounding measurements will be presented and discussed. Since no GPS receiver data are available close to the ionospheric sounding stations, we have used data recorded by two of the Brazilian Network GPS stations (operated by Instituto Brasileiro de Geografia e Estatistica), at Braslia (15.9 S, 47.9 W; dip lat. 11.7 S) and Imperatriz (5.5 S, 47.5 W; dip lat. 2.9 S). Phase fluctuations observed at these two stations from the GPS observations are compared with the ESF measurements carried out by the ionospheric sounding observations.

Keywords: ionosphere, plasma irregularities, equatorial spread f

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

JAS009 **Poster presentation** **568**

The generation of intermittent and localized medium-scale neutral winds in the E and F regions of the thermosphere from the dissipation of gravity waves originating from convection

Dr. Sharon Vadas
Colorado Research Assoc NorthWest Research Associates IAGA

D. C. Fritts

Gravity waves (GWs) are generated efficiently from the overshooting of deep, convective plumes near the tropopause. Some of these smaller-amplitude GWs can propagate up through variable wind and temperature structures in the stratosphere and mesosphere without dissipating, saturating, reflecting, or reaching critical levels. Once in the thermosphere, these GWs are subject not only to wind and temperature effects, but also to severe damping due to kinematic viscosity and thermal conductivity. Because dissipation depends sensitively on a GW's intrinsic parameters, it acts like a spectral filter on a GW spectrum with altitude. Using a new, complete, dissipative, anelastic GW dispersion relation, we describe how the dissipation of these GWs in the thermosphere creates horizontal thermospheric body forces. These body forces are intermittent and spatially-localized, occurring for the duration of deep convection and over horizontal patch sizes of 500-1000 km. Using a new compressible model, we show how these horizontal body forces generate spatially-localized and intermittent thermospheric neutral winds and medium-scale secondary GWs/traveling ionospheric disturbances (TIDs) in the thermosphere. These horizontal neutral wind patches are oriented roughly in the direction opposite to prevailing thermospheric winds, have a vertical extent dependent on solar conditions, and last for at least the duration of deep convection. The neutral wind strength depends on solar conditions and the updraft velocities of the deepest convective plumes. These neutral winds can last beyond the time when GW dissipation ceases, depending on the strength of the kinematic viscosity at the body force altitude. These body forces are expected to play an as-yet-undetermined dynamical role in the thermosphere, especially near equatorial latitudes in the Intertropical Convergence Zone (ICZ). Additionally, some GWs propagate through these neutral wind patches while they are being formed, and may have the appropriate characteristics to enable seeding plasma instabilities and equatorial spread-F.

Keywords: gravity waves, ray tracing, thermosphere

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

JAS010 **569 - 578**

Symposium
Magnetic field forcing of the thermosphere

Convener : Prof. Hermann Luhr
Co-Convener : Dr. Huixin Liu

The study of thermospheric dynamics has become new impulses by the advent of satellite missions, such as CHAMP and GRACE, carrying sensitive accelerometers on board. From the recorded air drag it is possible to derive the details of mass density and wind distribution. The CHAMP satellite also provides in addition measurements of the ionospheric currents, the plasma density and temperature. These global and high-resolution simultaneous observations have revealed prominent new features of the thermosphere unrealized before. These include the air density bulge in the cusp region, a double-hump distribution at middle latitudes similar to the equatorial ionization anomaly, and strong winds channeled along the dip equator instead of the geographic equator. All reflects a strong magnetic control of the thermosphere. The upcoming ESA SWARM mission is a 3-satellite constellation mission. Each satellite will carry a full suit of electromagnetic instruments together with an accelerometer. These multi-point measurements provide high perspective to identify the dynamics processes leading to these features. The exciting new features challenges our classical picture about the thermospheric wind and density depicted by MSIS and HWM models, and are reshaping our view of the T-I coupling. This session will serve on one hand as a forum for discussing the most recent and prominent development of the T-I coupling in terms of magnetic forcing, on the other hand, as a meeting announcing new T-I research possibilities with the SWARM mission. Comparative modeling studies, ground and satellite observations, and theoretical studies related to wind dynamo, wave-particle interaction, atmospheric chemistry are welcome They may help to understand the true features of the ionosphere-thermosphere coupling. Studies in preparation of the SWARM mission will also be included

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

JAS010 **Oral Presentation** **569**

Longitude dependences of thermospheric zonal winds at dip equator latitudes as derived from CHAMP

Mrs. Kathrin Haeusler
Section 2.3 Earth Magnetic Field GFZ Potsdam IAGA

Hermann Luehr, Wolfgang Koehler

The equatorial overflights of the CHAMP satellite during the years 2002-2004 are used for a detailed statistical study on the longitudinal dependence of the thermospheric zonal wind at dip equator latitudes. Due to the good data coverage of the satellite, it is possible to consider several aspects at the same time. For this analysis we derived the longitudinal variation of the zonal wind at about 400 km altitude and investigated its dependence on solar flux, magnetic activity, and season. Major longitudinal dependences are observed during the morning hours, 03-09 local time (LT). The wind direction of the delta wind (deviations from the zonal average) reverses sign between the June and Dec. Solstices. During Equinox seasons these large-scale features are almost absent. The flux level of solar EUV has no significant influence on the longitudinal variations. A dependence on magnetic activity could only be found during the post-sunset hours, 18-21 LT. In the precessing satellite frame, the Earths atmosphere displays a wave-4 structure in longitude. Considering only the nonmigrating (non-Sun-synchronous) tidal components, this prevailing feature has been recently reported, e.g. in temperature measurements detected by the SABER instrument on TIMED in the Mesosphere Lower Thermosphere (MLT) region. In this region the basic wave responsible for the wave-4 pattern is said to be the eastward propagating diurnal tide with zonal wavenumber 3 (DE3). This wave is primarily excited by latent heat release resulting from deep tropical convection in the troposphere. Performing a Fourier transform of our delta wind velocities, we could also find a dominance of the wave-4 in the zonal wind at some LT sectors in the Equinox data. Right now it is still unclear which mechanism causes the wave-4 structure at CHAMP altitude, but this first study of zonal wind longitudinal dependences provides new observational evidence for the coupling of the various atmospheric layers.

Keywords: thermosphere, winds, tides

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

JAS010 **Oral Presentation** **570**

Statistical studies on local thermospheric cusp density enhancements

Mrs. Stefanie Rentz
2.3 Earth Magnetic Field GeoForschungsZentrum Potsdam IAGA

Hermann Luehr, Wolfgang Koehler

With its onboard accelerometer the mini-satellite CHAMP is well-suited to investigate the density and wind distribution at its orbit height of approximately 400 km altitude. Taking about 90 minutes to fulfill one orbit on an almost polar, circular path, it enables us to consider thermospheric processes on a global scale. Due to the high accelerometer sensitivity it also allows to track local phenomena. A prominent one is the density anomaly bound to the cusp region. The satellite records air drag peaks during cusp overflights. The resulting density variations were investigated in event studies, where a possible driving mechanism was supposed to be incoming magnetosheath plasma, which can easily penetrate to lower altitudes in the cusp region, causing ionospheric currents, which may fuel Joule heating. These event studies initiated a statistical investigation on the local phenomenon. The applied data set consists of three years of accelerometer data. The statistical analysis reveals dependences on solar activity, season and solar zenith angle: The amplitude of the enhancement strongly depends on the level of solar EUV radiation. It decreases by a factor of 3 between 2002 (average yearly F10.7 = 179) and 2004 (average yearly F10.7 = 107). For the northern hemisphere, the density distribution also displays a clear seasonal variation with weakest amplitudes in summer and largest amplitudes during autumn and winter (mean ratio autumn/summer = 1.1). Whilst the density enhancement is confined to the noon sector during high solar zenith angles, it is shifted towards the afternoon during low solar zenith angles. To identify and investigate possible causes, a combined CHAMP-EISCAT campaign was initiated in October 2006. While recording the thermospheric responses by satellite the simultaneously ISR-measured ionospheric parameters can be used to calculate conductivities, electric fields and Joule heating rates, which can provide helpful information about the altitude range of the heating area or the driving processes. These mechanisms are believed to be an important coupling factor between the ionospheric plasma and the thermospheric neutral gas. The thermospheric up-welling at cusp latitudes seems to be a rather continuous process that may be regarded as a contribution to the thermospheric mid-latitude density enhancement.

Keywords: density, interaction, cusp region

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

JAS010 **Oral Presentation** **571**

Contrasting behavior of the thermosphere and ionosphere in responses to the Oct. 28, 2003 solar flare in equatorial anomaly regions

Dr. Huixin Liu
Earth and Planetary Science Hokkaido University IAGA

H. Luehr, S. Watanabe

This study utilizes simultaneous observations of the electron and thermospheric density from the CHAMP satellite to study the thermospheric and ionospheric responses to the solar flare event on Oct. 28, 2003. Interesting features were observed in the ionosphere and thermosphere and their coupling during such a transient event. First, the thermospheric response time was found to be within a few minutes, much shorter than traditionally assumed. Second, the latitudinal distribution in the flare-induced neutral and plasma perturbations contrasts each other remarkably. The thermospheric density was enhanced by 20% almost homogeneously at all latitudes between about 50° S -- 50° N within 20 minutes after the flare EUV burst. However, the electron density disturbance exhibited a distinctive latitudinal structure. It consisted of a largest enhancement of about 68% at the dip equator, small increase below 20% in mid-latitudes, and depression up to 35% between 10° -- 20° N/S. Third, the EIA structure was significantly weakened during the flare. The CHAMP observations demonstrates that electrodynamics related to the equatorial fountain dominated the photo-chemistry in controlling the n_e disturbances in the equatorial anomaly regions during the flare event on Oct. 28, 2003.

Keywords: neutral plasmainteraction, equatorialanomaly

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

JAS010 **Oral Presentation** **572**

Average thermospheric wind patterns over the polar regions during solstices, as observed by CHAMP

Prof. Hermann Luhr
Earth Magnetic Field GeoForschungsZentrum Potsdam IAGA

Huixin Liu, Patricia Ritter, Katrihn Husler

Measurements of the CHAMP accelerometer are utilized to investigate the average thermospheric wind distribution in the polar regions at altitudes around 400 km. In this study special emphasis is put on the seasonal differences in the wind patterns. For this purpose 131 days centered on the June solstice of 2003 are considered. Within that period CHAMPs orbit is precessing once through all local times. The cross-track wind estimates are averaged in equal-area cells. Both hemispheres are considered simultaneously providing summer and winter responses for the same prevailing geophysical conditions. The period under study is characterized by a high magnetic activity (Kp = 4-) but moderate solar flux level (F10.7 = 124). Our analysis reveals clear wind features in the summer (northern) hemisphere. Over the polar cap there is a fast day-to-night flow at speeds surpassing 500 m/s. At auroral latitudes we find strong westward zonal winds on the dawn side, however, on the dusk side an anti-cyclonic vortex is forming. The dawn/dusk asymmetry is attributed to the combined action of Coriolis and centrifugal forces. The winter (southern) hemisphere reveals similar wind features, but they are less well ordered. The mean day-to-night wind over the polar cap is significantly weaker, and its direction is rotated by some 30 towards the pre-midnight sector. We regard this as an indication for the stronger influence of the Coriolis force on the slower anti-sunward air flow. Also the fast zonal wind on the dawn side is not well developed here. Generally, the lower neutral density seems to allow for a stronger influence of the plasma dynamics. This is manifested in the significantly larger standard deviation of the thermospheric wind velocities.

Keywords: thermosphere, wind, polar region

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

JAS010 **Oral Presentation** **573**

Thermospheric signature of medium-scale field-aligned currents at auroral latitudes

Dr. Patricia Ritter
GeoForschungsZentrum Potsdam GeoForschungsZentrum Potsdam IAGA

Hermann Lhr, Stefanie Rentz

Field-aligned currents are an important mechanism for transporting energy and momentum from the solar wind into the upper atmosphere at high latitudes. The efficiency of energy dissipation depends on the ionospheric conductivity and the transverse scale size of the field-aligned current circuits. According to Vogt (2002) the conversion of electric current into heat should be most effective for scales of the order of some 10 km when typical ionospheric conductivities are considered. In order to test this conclusion we have performed a statistical analysis. This study is based on FACs that are derived from CHAMP magnetic field measurements taken during the years 2002-2004. FAC densities within the wavelength band 15-150 km are considered. The thermospheric mass density recorded simultaneously is used as a measure for the heat deposited in the ionospheric E-layer. The relation between FAC strength and thermospheric heating is determined in a superposed epoch analysis. The analysis is performed for diverse local time sectors. As expected, the thermospheric response differs significantly along the auroral oval. In particular, we cannot confirm the distribution of Joule heating as predicted from statistical FAC models.

Keywords: thermospheric heating, field aligned currents, champ magnetic field

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

JAS010 **Oral Presentation** **574**

CHAMP observations of neutral density enhancement associated with polar cap convection

Mr. Soga Sato
Earth and Planetary Science Hokkaido University IAGA

Huixin Liu, Shigeto Watanabe, Hermann Luehr

Thermospheric neutral atmosphere in the high-latitude region has been investigated with CHAMP satellite and SuperDARN. Accelerometer on the satellite provides us with the thermospheric neutral density and the cross-track wind velocity. SuperDARN observes ionospheric F-region plasma drift and derives the two-dimensional plasma convection velocity. The neutral wind directions obtained by CHAMP satellite corresponded with those of the plasma drift from SuperDARN. The results show that the strong interaction between neutral atmosphere and plasma is important in the topside polar ionosphere. Moreover, CHAMP satellite found the neutral density enhancements in the equatorward region of polar cap convection, where strong velocity shear occurs. We suggest that the frictional heating occurs in the polar cap region of velocity shear and the neutral atmosphere is heated.

Keywords: frictional heating, convection

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

JAS010 **Oral Presentation** **575**

Thermosphere response to solar wind forcing during magnetic storms

Dr. Aurelie Marchaudon
LPCE CNRS IAGA

Lathuillere Chantal, Menvielle Michel

Solar wind forcing during magnetic storms results in enhanced high latitude convection electric field and particle precipitation in the magnetosphere. It causes Joule and particle heating in the auroral thermosphere, resulting in thermospheric disturbances at the planetary scale. Using thermospheric densities deduced from STAR accelerometer measurements onboard the CHAMP satellite, we estimate by means of a SVD analysis method, a global scale coefficient describing the thermospheric density response to geomagnetic forcing, for latitudes in the range 50N to 50S. For periods of large density disturbance, we correlate this coefficient with magnetic activity and investigate its relations with the solar wind conditions. We focus on events with a clear magnetic cloud signature at L1. Magnetospheric activity is monitored using several classical IAGA geomagnetic indices, as well as the new longitude sectorial indices. Solar wind parameters are obtained from the ACE satellite.

Keywords: thermosphere, storm

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

JAS010 **Oral Presentation** **576**

Neutral density holes, fountains, and supersonic winds associated with magnetic field influences

Dr. Robert Schunk
Center for Atmospheric and Space Sciences Utah State University IAGA

Howard G. Demars

The thermosphere exhibits a background state (climatology) and a disturbed state (weather), both of which are strongly influenced by the geomagnetic field. The variability of the background state is fairly well established, although there is still a problem with regard to getting reliable quantitative predictions. In contrast, our understanding of the processes that produce the disturbed state is rudimentary. The variability of the disturbed state can result from geomagnetic storms and sub-storms, mesoscale ionospheric structures, traveling atmospheric disturbances that propagate away from the auroral oval, upward propagating gravity waves from the lower atmosphere, and both rapid time variations and spatial structure in the auroral energy inputs. For example, during geomagnetic disturbances and near discrete auroral features, observations have shown the thermosphere to be highly structured, with spatial scales varying from 50 to 500 km. The thermosphere was also observed to exhibit fairly rapid temporal variations, with time scales as short as 10-30 minutes. In addition, during periods of enhanced plasma convection, the neutral winds can become supersonic in relatively narrow regions of the polar cap. The variability and structure of the thermosphere can be associated with propagating plasma patches, auroral and boundary blobs, equatorial plasma bubbles, polar cap arcs, discrete auroral arcs, and sub-auroral ion drift events (SAID). The variability and structure can appear in the form of propagating atmospheric holes, neutral gas fountains, neutral density patches, and transient neutral jets. The variability associated with these and other neutral gas disturbances have been modeled with a time-dependent, high-resolution, global model of the thermosphere and the simulation results and supporting measurements will be presented.

Keywords: holes, fountains, supersonic flow

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

JAS010 **Oral Presentation** **577**

Discussion of models inadequate spatial distribution of energy into the thermosphere during storms

Prof. Jan Sojka
Center for Atmospheric and Space Sciences Utah State University IAGA

Rod Heelis

At this time fully coupled magnetosphere-ionosphere-thermosphere models are in their infancy. These models are not yet capable of generating accurate specifications of how energy is deposited into the thermosphere during geomagnetic storms.Empirical models of the major storm inputs to the thermosphere-ionosphere include the electric fields, auroral precipitation, and conductivities. These empirical models all lack adequately large data bases for high Kp to provide sufficient characteristics of these storm inputs to the I-T system.The cutting-edge capability of assimilation modeling of the ionosphere using the "full-physics" approach could contribute to describing storm drivers. This approach is still in its infancy and will require significant development over the next few years.The presentation will concentrate on measurements made both from the ground and space during storm periods. These measurements are used to establish the magnitude of under-representation in present day modeling efforts of the storm inputs. We consider the location of boundaries in the high-latitude convection pattern, the electrojet current, and the particle precipitation boundaries, etc. as well as the temporal duration of such storm time evolutions. Consideration is given to the sensitivity of the I-T to these redistributed drivers. The discussion will use these results to clarify the challenges in making adequate measurements during the storms, both their spatial distribution as well as the type of measurements that are needed. The need for coupled storm-time driver models of the electric fields, auroral precipitation and conductivities is highlighted.

Keywords: thermosphere, energetics, magnetospheric

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

JAS010 **Oral Presentation** **578**

Global Effects of Subauroral Electric Fields on the Thermosphere

Prof. Phillip Anderson
W. B. Hanson Center for Space Sciences University of Texas at Dallas IAGA

Geoff Crowley, William R. Johnston

Ionospheric electric fields can have profound effects on the thermospheric composition and winds, particularly during geomagnetic activity. They influence numerous processes in the ionosphere/thermosphere (IT) system including plasma transport in the ionosphere, the ion drag force which affects neutral winds, and the Joule heating which drives much of the composition and structure of the IT system. They can extend to very low latitudes and can contribute substantially to the magnetospheric electric field structure, particularly during geomagnetic storms. Modelers have begun to understand the importance of the subauroral electric field coupling to the thermosphere, the inner magnetosphere and the plasmasphere and efforts to incorporate recent results are currently underway. We are examining the effect of the subauroral electric fields on IT coupling using an empirical model of the subauroral electric fields derived from data acquired by several low-Earth orbiting (LEO) spacecraft. The results are being incorporated into the Thermosphere Ionosphere Mesosphere Electrodynamics General Circulation Model (TIME-GCM) to examine the global effects of the subauroral electric fields on the thermospheric structure. We will show our initial results, comparing the global thermospheric structure derived from TIME-GCM for select geomagnetic storms using a strictly high-latitude electric field model with thermospheric structure derived using an electric field model incorporating the subauroral electric field.

Keywords: thermosphere, ionosphere

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

JAS011 **579 - 590**

Symposium
The Sound of Physics: Advances in coronal, helio-, astero- and terrestrial seismology

Convener : Dr. Travis Metcalfe

Seismological techniques are now being applied in regimes throughout the universe to elucidate the physical properties and behavior of dynamic structures. Sound waves, magneto-hydrodynamic waves, and other propagating disturbances allow researchers to "sound out" the interior structure and dynamics of a wide range of geophysical and astrophysical objects. The development of remote sensing techniques using Doppler signatures have allowed us to determine the interior flows and structure of the Sun, providing an unprecedented view of the inner workings of our nearest star. Additionally, the field of asteroseismology is helping us to perform similar research on other stars, which in turn allows us to better understand our own Sun by providing other data points on the stellar spectrum. The new field of coronal seismology is providing the ability to deduce physical parameters that aren't accessible through direct observations, by modeling the dynamics of structures in the solar atmosphere in response to a variety of impulsive transients. As these applications of seismology continue to flourish, terrestrial seismologists have also produced new advances in data collection and interpretation. This special session welcomes presentations on scientific results, innovative techniques, and new applications in all fields of seismology, with a special emphasis on the parallels between these fields.

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

JAS011 **Oral Presentation** **579**

Observational helioseismology: sounding the interior of the Sun

Dr. William Chaplin
School of Physics and Astronomy University of Birmingham, UK

Observational helioseismology traces its beginnings back to the early 1960s and the first detection, by Bob Leighton and Bob Noyes, of 5-minute oscillations of small patches of the surface of the Sun. It took until the mid 1970s for the internal standing-wave nature of the phenomenon to be verified by observation, and a further half decade or so until the truly global nature of the 5-minute modes was established. The acoustic modes give a precise probe of the interior, right down to the solar core. The rich spectrum of acoustic modes continues to be monitored by state-of-the-art observing programmes, including space-borne instruments and ground-based networks. In this talk I will review some of the historical developments in observational helioseismology, and discuss the modern challenges facing observers, in particular detection of internal gravity (buoyancy) modes.

Keywords: helioseismology, sun interior

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

JAS011 **Oral Presentation** **580**

Seismology: Observations in Solar and Stellar Coronae

Dr. Markus J. Aschwanden
Solar and Astrophysics Laboratory, Lockheed Martin Lockheed Martin, ATC, Org. ADBS IAGA

We review observations of various MHD oscillation modes (fast kink mode, fast sausage mode, slow [acoustic] mode) and propagating (acoustic and Alfvenic) MHD waves in the solar corona. Using loop scaling laws and stellar flare observations we extrapolate and estimate the physical parameters of oscillating loops in stellar coronae, and discuss recent quasi-periodic oscillations reported from stellar observations.

Keywords: solar corona, stellar corona, mhd oscillations

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

JAS011 **Oral Presentation** **581**

Recent Advances in Theoretical & Computational Seismology

Prof. Jeroen Tromp
Seismology California Institute of Technology IASPEI

Synthetic seismograms are at the heart of modern seismology. For spherically symmetric Earth models, normal-mode summation is the preferred method for the calculation of broadband seismograms. Before fully three-dimensional (3D) numerical techniques became available and practical, one had to resort to asymptotic methods for the calculation of synthetic seismograms. Nowadays, seismologists are calculating fully 3D synthetic seismograms at the scale of the globe. To date, the most successful numerical technique for simulating 3D global seismic wave propagation has been the spectral-element method (SEM). The SEM has been used for more than two decades in computational fluid dynamics, but it has only recently gained popularity in seismology. Like a classical finite-element method, the SEM is based upon an integral or weak implementation of the equation of motion. It combines the accuracy of the global pseudospectral method with the flexibility of the finite-element method. The wavefield is typically represented in terms of high-degree Lagrange interpolants, and integrals are computed based upon Gauss-Lobatto-Legendre quadrature, which leads to a simple explicit time scheme that lends itself very well to calculations on parallel computers. The current challenge lies in harnessing these numerical capabilities to enhance the quality of tomographic images of the Earth's interior, in conjunction with improving models of the rupture process during an earthquake. Tarantola (1984) demonstrated that this problem may be solved iteratively by numerically calculating the derivative of a waveform misfit function. The construction of this derivative involves the interaction between the wavefield for the current model and a wavefield obtained by using the time-reversed waveform differences between the data and the current synthetics as simultaneous sources. Only two numerical simulations are required to calculate the gradient of the misfit function: one for the current model and a second for the time-reversed differences between the data and the synthetics. Talagrand & Courtier (1987) generalized the calculation of the derivative of a misfit function by introducing the the concept of an

Keywords: computational seismology, inverse problems, adjoint methods

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

JAS011 **Oral Presentation** **582**

Theoretical aspects of helioseismology

Dr. Laurent Gizon
MPS MPS IAGA

Solar oscillations contain a wealth of information. There are various ways to interpret the observations. Global helioseismology consists of searching for a solar model that provides a good match between the observed and model frequencies of the normal modes of oscillation. This approach has been successful in determining longitudinal averages of the internal structure and rotation of the Sun. More recent methods of local helioseismology propose to interpret the full wave field observed at the Sun's surface. An important goal is to image small-scale subsurface inhomogeneities like sunspots and active regions. I shall discuss the strategies used to model wave propagation in the solar interior, insisting on the many connections that exist between the seismology of the Sun and the Earth.

Keywords: helioseismology

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

JAS011 **Oral Presentation** **583**

Theoretical aspects of solar and stellar coronal seismology

Dr. Valery Nakariakov
Physics University of Warwick IAGA

Coronal seismology is a new, rapidly developing branch of Astrophysics, aiming remote diagnostics of solar and stellar coronal plasmas by means of magnetohydrodynamic (fast and slow magnetoacoustic and Alfven) oscillations and waves. Theoretical foundation of Coronal Seismology - the magnetic cylinder model - successfully predicted the presence and properties of kink, sausage and longitudinal modes of coronal plasma structures. The analysis of observationally determined properties of these modes allows us to estimate the key physical parameter of the coronal plasmas which are not open to the direct measurement by other methods: the magnetic field, transport coefficients, heating function, sub-resolution structuring. The review covers the current trends in the theoretical aspects of coronal seismology.

Keywords: corona, mhd waves, diagnostic

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

JAS011 **Oral Presentation** **584**

Distant flare to flare triggering via waves

Dr. Olena Podladchikova
Solar Physics IAGA

Vladimir Krasnoselskikh, David Berghmans, Valery Nakariakov

Intensive coronal acoustic waves are often induced by flares, and were observed travelling in waveguides formed by magnetic flux tubes (Robbrecht et al., 2000) or as blast waves propagating in particular coronal layers (Kosovichev 2006). Whether such waves can trigger remote flares and result in "sympathetic flaring" remains an open issue. Although solar flare databases have included flare timing information for a long time, only recently systematic spatial information was included in data centers such as at NOAA (USA) and SIDC (Belgium). Using 2002-2006 years of such data and methods inspired by those used in time-distance heliosismology, we provide evidence that some distant flares might be related by perturbations travelling from one to the other, and find the characteristic perturbation velocity.

Keywords: seismology, sun, waves

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

JAS011 **Oral Presentation** **585**

Absorption of p-modes by a thin magnetic fluxtube

Dr. Mykola Gordovskyy
Applied Mathematics Dept. University of Sheffield

Rekha Jain

Observations show that sunspots may absorb up to 50% of the incident acoustic wave flux. This gives an opportunity to study the subsurface structure of sunspot magnetic fields from the observations of solar p-modes.In the present work we study scattering and absorption of p-modes by model sunspots. Wave functions are calculated numerically by solving a set of linearized MHD equations for various fluxtube and incident p-mode parameters. Obtained solution is used to deduceabsorption rates and phase-shifts of the scattered p-modes.Effect of sunspot radius, magnetic field strength and magnetic field convergence on the resulting absorption rates is discussed. We alsocompare phase shifts of scattered p-modes calculated numerically with those obtained in Born Approximation.

Keywords: helioseismology, sunspot

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

JAS011 **Oral Presentation** **586**

Observational Asteroseismology

Dr. Hans Kjeldsen
Physics and Astronomy University of Aarhus IAGA

Timothy R. Beding

For several decades the study of solar oscillations and the application of seismic analysis techniques through helioseismology have provided a revised and extremely detailed view of our nearest star, the Sun. Although the Sun is indeed a special case in that it provides possibilities to study the oscillation properties at local as well as global spatial scales, one can foresee a similar improvement in tests of stellar structure and evolution when we detect solar-like oscillations in other stars. In thistalk we discuss the latest results from observing solar-like p-mode oscillations and demonstrate that we are now obtaining detailed information on the oscillation properties, such as individual p-mode frequencies and mode lifetimes. We will in the present talk present the newest analysis of oscillation frequencies in alpha Centauri A and B, beta Hydri, Procyon and nu Indi.

Keywords: asteroseismoloy, stars, oscillations

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

JAS011 **Oral Presentation** **587**

Magnetoseismology: Seismology for the Magnetosphere

Dr. Peter Chi
Institute of Geophysics and Planetary Physics UCLA IAGA

The terrestrial magnetosphere is where the Earths magnetic field dominates and forms a bubble-like structure pushing against the solar wind, and the region encompasses the plasmasphere, a current system, and radiation belts that could create a hazardous environment for the satellite network. The magnetosphere has a rounded shape in the dayside and a long tail in the nightside, and its size is controlled by the solar wind and the interplanetary magnetic field. Despite the irregular and variable shape of the magnetosphere, two magnetoseismic methods have succeeded in inferring the density distribution of the magnetosphere from the observations by ground stations or satellites. The normal-mode method makes use of the field line resonance that is prevalent in the dayside magnetosphere. Coordinated ground observations of field line resonance through the use of the gradient method have been valuable in monitoring the magnetospheric density and how it varies during magnetic storms. The travel-time method is analogous to timing the arrival of seismic waves except that the impulses are caused by either the sudden compressions at the subsolar magnetopause or the substorm onsets in the magnetotail. A unique characteristic of magnetoseismology is that the relevant wavelengths are usually comparable to the scale length of velocity gradient, calling for a very different forward model from the ones used in helio- and terrestrial seismologies. This paper presents an overview of the two magnetoseismic methods, their similarities to and differences from other types of seismologies, the cutting edge of this relatively young research field, and the potential impact on magnetospheric research.

Keywords: magnetoseismology, magnetosphere, mhd waves

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

JAS011 **Oral Presentation** **588**

Recent progress in global terrestrial seismology

Prof. Barbara Romanowicz
Berkeley Seismological Laboratory University of California at Berkeley IASPEI

The investigation of deep earth structure has been greatly enhanced over the last 25 years by the gradual deployment, through international efforts, of a global network of very broadband, high dynamic range, state-of-the-art seismographs, associated digital on-line archives of seismic waveforms and a well-established practice of data sharing in the global seismology community. In addition, temporary arrays deployed in many regions of the world have enabled higher spatial resolution studies in some continental areas. Recently, increased efforts at regional densification hold the promise of effective application to the study of the deep earth of methodologies first developed in exploration geophysics. Recently also, increase in computational power coupled with progress in applied mathematics have allowed the introduction of accurate numerical methods to compute the seismic wavefield in a strongly heterogeneous earth with spherical geometry, and the associated inversion kernels, providing unprecedented capabilities to resolve finer scale 3D structure within the earth. I will discuss progress made over the last 20 years in global mantle tomography, and in forward modeling of finer scale structure, in particular in the deepest mantle,in the context of our understanding of global mantle dynamics. I will present my views on what I think are the current challenges in this field, and put into perspective theoretical progress and issues resulting from sampling limitations imposed by the distribution of earthquake sources and receivers. If time permits, I will also briefly discuss the structure and anisotropy of the earth's solid inner core.

Keywords: seismology

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

JAS011 **Poster presentation** **589**

Theoretical aspects of asteroseismology: how to get inside a star

Dr. Maria Pia Di Mauro
INAF IASF ROMA IAGA

The formidable role played by the helioseismology for the detailed comprehension of the structure and dynamics of the Sun has spurred investigators to extend this diagnostic technique to other stars which may show multi-mode pulsations, opening the doors to its daughter discipline, the asteroseismology. Small amplitude multi-mode pulsators occupy broad regions of HR-diagram, reflecting the fact that stars can show pulsations in several phases of their life, from main-sequence, to the immediate post main-sequence regions, to extreme horizontal branch, and on the white-dwarf cooling sequence. Unfortunately, inferences of the interior of the stars other than the Sun appear to be much more complicated and less outstanding in terms of obtainable results. In fact, it is obvious that the quantity and the accuracy of observational data available for the Sun will never be achieved in the case of a more distant star. However, several techniques have been developed or adopted from helioseismology to probe the internal structure and dynamics of stars. Here I will review on the theoretical aspects of asteroseismology, considering methods and tools available today to manipulate observed frequencies of oscillation in order to investigate the evolutionary and structural properties of the stars.

Keywords: stars, oscillations, asteroseismology

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

JAS011 **Poster presentation** **590**

Structural variations of the near-surface layers of the Sun over solar cycle 23

Dr. M. Cristina Rabello-Soares
HEPL Solar Physics Stanford University

Sylvain G. Korzennik

Using full-disk observations obtained with the Michelson Doppler Imager (MDI) on board the Solar and Heliospheric Observatory (SOHO) spacecraft, we analyse variations of the structure of the near-surface layers of the Sun caused by the solar activity cycle. High-degree (100 $< ell <$ 900) solar acoustic modes were analyzed using global helioseismology analysis techniques over most of solar cycle 23. We followed the methodology described in details in Korzennik, Rabello-Soares and Schou (2004) to infer unbiased estimates of high-degree mode parameters. Reference: Korzennik, S. G., Rabello-Soares, M. C., & Schou, J., On the determination of Michelson Doppler Imager high-degree mode frequencies, 2004, Ap.J., 602, 481-515.

Keywords: helioseismology, solar activity, sun

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

JAS012 **591 - 626**

Symposium
Seismological, geological and tectonic interpretation of geomagnetic anomalies on continents and oceans

Convener : Dr. Kumar Hemant
Co-Convener : Dr. Shigeo Okuma

Magnetic anomaly maps derived using near-surface and satellite data reveal distinctive magnetic anomalies from continents and oceans. These anomalies are routinely used to model and interpret the sources in terms of plate motion, crustal structure, geology and chemical composition of the Earth's crust, utilising seismic data as a constr! aint. The session solicits contributions dealing with seismic and magnetic data to reveal new geological and tectonic information of the Earth's continents and oceans. Papers concerning related works such as high-resolution magnetic surveys especially in active tectonic environments are also welcome.

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

JAS012 **Oral Presentation** **591**

Integrated use of Enhanced Thematic Mapper plus (ETM+) remote sensing data and airborne magnetic data as an aid to geological and environmental applications in South Western Desert, Egypt

Prof. Nasser Ali
Geophysics Department Fac.of Science,Ain Shams University IAHS

Aboulhoda M. Elsirafy, Maged L. El Rakaiby, Salah-Eldin A. Mousa, Mehress A. Abdel Mohsen

The present study is an attempt to asses the best methods of integrated use of Enhanced Thematic Mapper plus (ETM+) Remote sensing data and airborne magnetic data as an aid for geological mapping, structures delineations , and environmental monitoring in the area lying in the south of the Western Desert of Egypt. Conversion of griddled geophysical data to a common image format made it possible to display and manipulate the suitable geophysical features. Qualitative and quantitative interpretation of aerial geophysics are mainly devoted towards the achievement of these goals. The aerial geophysical griddled data covering the studied area have been converted to the common image format, to display and manipulate these originally non-image data by standard digital image processing techniques. In this way, some interesting false color composite images were produced for some selected combinations from the various geophysical parameters. These images provided extremely useful synthesis of the data that enabled the extraction of more geological and geochemical information from this geophysical data set. The produced geophysical composite images preserve the information content of the raw data and are far more amenable to visual interpretation than contour maps. The qualitative interpretation revealed the lithological differences and the structural belts in the area under study. Statistical analysis of revealed trends of both surface and near surface features as well as the deep seated lineaments could explain the significant structure gain that is responsible for the tectonic development of different geologic units in the area under study.

Keywords: remote sensing, airborne magnetic, structural applications

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

JAS012 **Oral Presentation** **592**

Further investigations into the aeromagnetic anomalies and earthquake potential of the Marmara region, NW Turkey

Prof. Abdullah Ates
Geophysical Engineering Ankara University

Aydin Byksara, Funda Bilim, Zcan Bektas, Igdem Sendur, Gonca Komanovali

Previous investigations into the deep structure of the Marmara Sea region revealed existence of a rigid barrier located at the centre of the Marmara Sea (Ates et. al., 2003). Thus, the North Anatolian Fault was divided into three branches towards west of this barrier. Seismological records of last 5 and 10 years show decrease on and around this barrier. Further investigation has been carried out over the aeromagnetic anomalies by utilising advance processing methods. Reduction to pole transformation (RTP) which removes the distortion caused by the Earths induced field was applied to the aeromagnetic anomalies. First derivative map of the aeromagnetic anomalies was also produced. By means of RTP transformation most of the anomalies appear to have only positive contour closures. This implies that most of the magnetized bodies have no or little magnetization. First derivative map shows features resembling lineaments which can be correlated with the faults. These faults are the Northern Boundary, Imrali and Edincik Faults. The length of the Northern Boundary Fault (NBF) is about 50-60 km. Thus, this fault would not produce strong earthquakes. Edincik Fault extends from east to west and bends WSW. The length of this fault with including Imrali Fault in the west exceeds 200 km. Thus, these faults may produce strong earthquakes. Seismic gaps can be observed along the Imrali and Edincik faults from the earthquake distribution records of the last 5 and 10 years. Thus, in these regions, there are high-potentials of strong earthquake occurrences. A recent earthquake of 4.2 ML dated 19th December, 2006 in Bayramdere (Bursa) close to these faults appears to be a sign of aforementioned suggestion. Reference: Ates, A., Kayiran, T. ve Sincer, I. 2003. Structural interpretation of the Marmara region from aeromagnetic, seismic and gravity data, Tectonophysics 367, 41-99.

Keywords: marmara region, aeromagnetic anomalies, earthquake potential

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

JAS012 **Oral Presentation** **593**

Derivation and Interpretation of the new World Digital Magnetic Anomaly Map

Dr. Michael Purucker
Planetary Geodynamics Lab Raytheon at Goddard Space Flight Center IAGA

The World Digital Magnetic Anomaly Map (WDMAM) is the first global compilation of aeromagnetic surveys, marine magnetometer traverses, and observations from earth-orbiting satellites. In addition to the included observations, a simulation of the marine magnetic pattern based on a digital age map of the oceans is included in areas lacking near-surface coverage. Both the published maps and the underlying digital data sets are being made available. We believe that this publication will lead to a renewed interest in the interpretation of these anomalies in terms of geology and tectonic processes, and will provide an impetus for magnetic exploration in presently unmapped areas. I will provide some examples of new interpretations based on this map.

Keywords: geomagnetism, continents, oceans

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

JAS012 **Oral Presentation** **594**

Volcanic structure obtained from magnetic potential using three components of geomagnetic anomaly fields

Prof. Nobuhiro Isezaki
Department of Earth Sciences Faculty of Scoence, Chiba University IAGA

The magnetic potential can be obtained from three componebts of magnetic field based on the definition of potential. I made a magnetic survey recently to get three components of geomagnetic field using a helicpter for the Aogashina Island, a volcano island in the south of Tokyo, Japan. To get the magnetic structure of the Aogashina Island, the equivalent surface method was applied following the method of the Green's equivalent surface. The three dimensional distribution of magnetic potential is obtained from observed three conponents of geomagnetic field gives the equi-potential surfaces above the Aogashima Island, the equivalent magnetization surfaces are also obtained using the normal gradient of potential on the equi-potential surfaces after the definition of Green's theory. The equivalent surface just on the surface of the ground or at the some depth of the ground by the extrapolation of equivalent layers above the island. The eqivalent layer has the magnetization intensity distribution from which the geological structure of the Aogashima Island can be estimated. Theoretically, the observation surface of geomagnetic field must be circle the source area, however, practically the magnetic survey can be conducted only in the restricted small area above and arounf the magnetic source. In the Aogashima's case, the island is so small and surveyed area is so wide that I think the discrepancy between the theoretical and practical cases is not so severe. The advantage of the magbetic potential instead of magnetic field for research of magnetic structure, is the effect of the distance r from the source to the observation point. The potential is proportional to 1/r, hoever magneric field is to 1/(r^3), then the feature of the distribution of potential is much simpler than that of magnetic field which leads the better confidence on the anaysis results. I will show the method of observationand analysis and the results of magnetic and geologic structure fir the Aogashima Island.

Keywords: magneticpotential, magneticthreecomponentanomaly, aogashimaisland

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

JAS012 **Oral Presentation** **595**

Tracing the origin of remanent crustal magnetic anomalies to oxidized igneous and metamorphic rocks: magnetic minerals and microstructures

Prof. Suzanne McEnroe
Geophysics NGU IAGA

Laurie Brown, Peter Robinson, Richard Harrison

Ability to map crustal magnetic anomalies has improved dramatically over the last few decades. Resolution of 0.5 nT is now achieved easily in aeromagnetic surveys and mapping the earth from satellites is producing new information about the crust and lithosphere. For decades most models have considered only induced magnetization as a cause for anomalies and there has been little focus has been on remanent anomalies. This was mainly because remanence rarely was thought to dominate continental crustal magnetic signatures, especially in older cratonic rocks though always considered for oceanic crust. In the last decade numerous studies have shown that remanence is important in certain rock types. The magnetic signature from different metamorphic and igneous rocks has been explored in detail including the role of micron-to-nanoscale intergrowths and exsolution microstructures. What settings provide the proper thermal conditions to promote exsolution during late stage uplift of cratonic crust? What igneous rocks are more likely to carry a remanent signature? Understanding the nature of formation and stability of these intergrowths will aid us in future aeromagnetic exploration and interpretation of satellite data in areas of old, cool cratonic crust.

Keywords: magnetic, minerals, anomalies

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

JAS012 **Oral Presentation** **596**

Multifractal scaling analysis of magnetic surveys as a constraint on proposed tectonic sequences

Dr. Mark Gettings
Mineral Resources Program U.S. Geological Survey

Multifractal scaling analysis has been used to compare magnetic susceptibility distributions from four models of the hydrothermal alteration sequence to the distribution of magnetic susceptibility measured in thirteen boreholes in the Needle Creek Igneous Center of the Absaroka Mountains, Wyoming, U.S.A. The magnetic susceptibility distribution in this dataset has about a 600m vertical extent, is highly variable, and has been demonstrated to exhibit multifractal scaling in a previous study. Models of the hydrothermal alteration resulting in depletion of the magnetic susceptibility are based on a multiplicative cascade process. The proportional multipliers during the cascade form a product in the final distribution. The products are associative and commutative and therefore the cascade model can produce the same distribution as a physical model of one or more stages of fracturing, each followed by one or more stages of chemical alteration reactions. Four models were calculated representing four different possible sequences of fracturing and alteration. Models corresponded to: 1) a single, large vertical extent fracturing and alteration event of more than 600m thickness; 2) the single fracturing event and two approximatly 80m vertical extent alteration events centered at different levels in the 600m data interval; 3) the single fracturing event with one large vertical extent (>600m) and one 80m vertical extent alteration events; and 4) two superimposed events of large vertical extent fracturing followed by alteration in non-coincident zones of approximately 80m thickness within the data interval. Fracturing was assumed to proceed to densities of approximately one per centimeter in the most fractured areas. Both the model simulations and the data were subjected to multifractal scaling analysis by two different methods. Both the f(alpha) and the zeta function scaling exponents were computed and used to compare models to the data. The models that best fit the data in a multifractal scaling sense were those whose vertical extent of alteration exceeded that of the data; that is, the alteration scale is at least as large as that of the data and there is no evidence of multiple narrow alteration pulses. Both methods of multifractal analysis applied discriminate well between models; the zeta function method was the most sensitive in distinguishing models in this study. Although the methods here were applied to drillhole-log data from thirteen boreholes within the deposit, the methods used can be generalized to two or three dimensions and could thus be readily applied to aeromagnetic map data. As shown by several studies, the vertical and horizontal multifractal magnetization distribution results in a multifractal distribution of magnetic anomalies in three dimensions. Thus the scaling properties ("texture") of aeromagnetic anomalies in map view can be used as a constraint on proposed tectonic event sequences. For proposed events that would alter the magnetization distribution (such as a regional pattern of intrusions, faulting, folding, and/or metamorphism), the hypothetical sequence would need to produce a similar pattern of scaling to that observed in the map distribution of magnetic anomalies.

Keywords: multifractal, magnetic surveys, anomaly texture

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

JAS012 **Oral Presentation** **597**

The reassembled geology of the North Atlantic Margins

Prof. Colin Reeves
WDMAM Earthworks BV IAGA

Uniform coverage of global magnetic anomalies provides a new tool for interpreting the tectonic evolution of our planet. Better understanding of the development of ocean basins allows the reconstruction of the continents prior to ocean development and this, in turn, assists in understanding the record of continental geology which covers a much longer span of history than do the oceans. We attempt here a new reconstruction of the margins of the North Atlantic Ocean at the time of Pangaea using the magnetic anomaly data of this ocean compiled in the new world digital magnetic anomaly map (WDMAM) and then assess the evidence of continental magnetic anomalies, juxtaposed in their pre-ocean configuration, as a mean of supporting the reconstruction and improving it. To make a valid comparison, the effects of the present-day magnetic field inclination and declination have to be removed from each fragment. We attempt pole reduction, analytic signal calculation and equivalent source methods to achieve this. The individual fragments of North America, Northwest Africa, Iberia, Western Europe, Scandinavia and Greenland are then reassembled with this data attached. The effects of the varying standards of data quality in the constituent areas are assessed.

Keywords: continental, reconstruction, northatlantic

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

JAS012 **Oral Presentation** **598**

Magnetic data interpretation over the Deccan Volcanic flood basalts, India.

Dr. Vinit Erram
Solid earth Geophysics Solid Earth Geophysics IAGA

S.P. Anand

The Deccan Trap is one of the Earth's giant continental flood basalts and has a total exposed area of about half a million square kilometers, between latitudes 16 - 24 N and longitudes 70 - 77 E. In the northwestern, central and southern Indian peninsula, the approximate volume of the DVP is about 2 x 106 km3 and its estimated age is 64-65 Ma. It is generally believed that the DVP originated during Gondwanaland breakup as part of the Seychelles-India separation event. The Deccan flood basalts may be major carriers of remanance and this will leave its signatures in the magnetic data. No aeromagnetic data has been collected over this region possibly because of the expected noise due to the trap cover and this leads to a large data gap in the aeromagnetic map of. Ground magnetic studies were undertaken over the Deccan trap covered regions in Maharashtra, parts of Karnataka and Goa for deciphering the magnetic anomalies over the Deccan Trap covered regions. The magnetic total field F was measured at a station spacing of 5 km. To study the source depth extent of the entire region; some rock samples were also collected for the NRM and the susceptibility studies. The laboratory study of collected samples of basaltic flows surprisingly reveals low susceptibility and Q ratio implying low remament magnetization in this area. The ground data over Deccan trap merges very well with the aeromagnetic and marine data showing the continuation of a very long lineament from Chennai across the subcontinent into the offshore region. Interpretation and the modeling of this data will be presented.

Keywords: magnetic anomalies, flood basalts, susceptibility

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

JAS012 **Oral Presentation** **599**

Investigating local crustal properties by inversion of magnetic anomaly measurements

Dr. Yoann Quesnel
Earth's Magnetic Field GFZ IAGA

Vincent Lesur, Mioara Mandea, Benoit Langlais, Christophe Sotin, Armand Galdeano

In the perspective of a 5-km altitude World Digital Magnetic Anomaly Map (WDMAM), coupled with other geophysical constraints such as given by seismics, more precise studies of local or regional properties of the Earth's lithosphere will be possible. The relationships between distribution, amplitude and wavelength of magnetic anomalies with the crustal structure, tectonic and geology are a key issue in geophysics. Using forward approaches, the magnetic anomaly predicted by simple magnetized bodies is often compared with the observed anomaly. Here, a step of inversion is added to objectively constrain a dipole model by magnetic measurements. Two cases of geomagnetic anomalies are shown: one concerns the Champtoceaux metamorphic complex (western France), whereas the other the Beattie anomaly (South Africa). In the two cases, these are E-W elongated anomalies, but the wavelength and the amplitude differ. Results of 2D or 3D investigation are presented and compared with some other geophysical information.

Keywords: inversion, geomagnetism, crust

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

JAS012 **Oral Presentation** **600**

Interpretation of geomagnetic anomalies across 85 E ridge in the bay of Bengal, India

Prof. Mita Rajaram
Solid Earth Group Indian Institute of Geomagnetism IAGA

S.P. Anand

The sedimentary basin of the Bay of Bengal is a very distinctive feature with thick loads of sediments supplied by the uplifting Himalayas, being carried into the Bengal Fan by the Ganges and Brahmaputra rivers. The thickness of the sediments reach 22 km at places thereby masking the underlying crust and posing severe restrictions in mapping the structural configuration and constructing the geodynamical history of the Bay of Bengal. The 85 E Ridge and the 90 E Ridge are two prominent features of the Bay of Bengal; although the 90 E Ridge is confirmed to be an emplacement of the Kergulen hotspot, the origin and evolution of the 85 E Ridge is much debated. In this paper we use available datasets over the Bay of Bengal, to understand the evolution of the 85 E ridge.The bathymetry, sediment thickness, gravity anomaly and magnetic anomaly along six EW profiles, each extending for around 400 km length and cutting across 85 E ridge, are utilized to understand the nature of the crust. The satellite derived free air gravity data was initially modeled to construct the crustal structure, using standard density parameters along with seismic, bathymetry and isopach data as constraints. Utilizing the crustal structure derived by modeling the gravity data, an attempt is made to model the NGDC marine magnetic data along these profiles, by incorporating remanent magnetization in addition to the induced field. The three layer model of Kent et al (1993) was adopted to incorporate the sea floor spreading. We find that the modeled magnetic anomalies along the different profiles are sensitive to the strike angle of the spreading anomalies. The final crustal model that reproduces the gravity and magnetic data in all the profiles, depict a very consistent reverse magnetization with thickening of the crust along 85E ridge. The width of the ridge determined from the model varies between 60 and 300km and is within the limits as interpreted from available seismic records. Though the magnetic anomalies exhibit a positive signature over the ridge, the anomalies exhibit asymmetry. This asymmetric nature of the anomalies, suggests that the ridge evolved at the southern latitudes. The results of these models will be interpreted in terms of the Sea floor spreading of the region and its implication for the Gondwana breakup.

Keywords: seafloorspreadinganomalies, 85eridge, geopotentialanomalies

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

JAS012 **Oral Presentation** **601**

The traill-vring igneous complex in the Greenland-Norwegian Sea, NE Atlantic

Dr. Odleiv Olesen
Division V: Geomagnetic Observatories and Surveys Geological Survey of Norway IAGA

Odleiv Olesen, Laurent Gernigon, Jrg Ebbing, Erik Lundin

Simplified palaeogeographic reconstruction of the aeromagnetic map to Anomaly 22 reveals that a c. 50 km wide and 600 km long magnetic anomaly cuts across spreading anomalies 24A, 24B and 23 from the Vring Marginal High on the Norwegian margin to Traill on the East Greenland margin. The anomaly is interpreted to represent an igneous complex referred to as the Traill-Vring Igneous Complex (TVIC). The complex crosscuts anomaly 22 on the Greenland margin, suggesting that the igneous activity was active until c. 50 Ma and can be linked up with the NNE-trending initial magmatic lineament extending between Traill and Kangerlussuaq. The lineament has been suggested to relate to a failed attempt of direct linkage between the Reykjanes and Mohns Ridges. The magnetic response of the TVIC along the Vring margin has previously been interpreted to represent a repetition of the spreading anomalies 24A and 24B. However, such an interpretation required the erroneous introduction of an abandoned spreading ridge. Our new interpretation suggests that the opening of the Norwegian-Greenland Sea between the Jan Mayen and Senja FZs occurred along a stable axis without offsets or jumps of the oceanic spreading axis as previously suggested. Interpretation of a more recent aeromagnetic survey along the Jan Mayen Fracture Zone has revealed that he TVIC may represent the leaky transform of a pseudo triple junction resembling the present day tectonic situation observed in the Azores Plateau in the south Atlantic.

Keywords: atlantic, aeromagnetic, modelling

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

JAS012 **Oral Presentation** **602**

New tectonic and crustal structure of the central Indian shield regions inferred from CHAMP satellite magnetic anomaly maps

Dr. Kumar Hemant
Planetary Geodynamics Laboratory Goddard Space Flight Center, NASA IAGA

Mike Purucker

Satellites derived magnetic anomaly maps have been instrumental in geological interpretation of the sub-surface crustal structure for more than two decades now. Highly reliable and accurate anomaly maps produced from low-orbit CHAMP satellite magnetometer data have now added a new dimension. The downward continued version of the global magnetic anomaly maps derived from CHAMP, in particular, MF4 and MF5, show anomaly features that depict a significant correlation with the major tectonic features of the continents and oceans. Here we attempt to model and interpret an anomaly feature that cuts across the Central Indian shield region extending from the west coast to the northeastern region of India. This striking feature, referred to as Central Indian Tectonic High (CITH), is also evident in the composite magnetic anomaly map prepared from a combination of aero, ground and marine magnetic data. Based on geological and tectonic information, a vertically integrated susceptibility (VIS) model is computed by taking product of the average susceptibility value and the crustal thickness of the region in and around CITH. Assuming the source of the anomaly to be entirely of induced origin, the predicted magnetic anomaly is compared with the corresponding region of the observed magnetic anomaly map for two different altitudes 50 and 400 km. Such a comparison is done to better understand and model the surface and sub-surface extension of this tectonic feature. We present here the preliminary results of our study.

Keywords: crustal, magnetic, interpretation

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

JAS012 **Oral Presentation** **603**

Aeromagnetic constraints on the upper crustal structure of seismogenic regions in the Japanese Islands

Dr. Shigeo Okuma
Institute of Geology and Geoinformation Geological Survey of Japan, AIST IAGA

Tadashi Nakatsuka, Hiroshi Kanaya

Interpretations of regional magnetic anomalies play an important role to better understand the upper crustal structure when the basement rocks which constitute the upper crust are magnetic. Aeromagnetic interpretations on the upper crustal structure of seismogenic regions in the Japanese Islands have been conducted using nation-wide geophysical databases of aeromagnetic anomalies and petrophysical properties of basement rocks created both by the Geological Survey of Japan, AIST. Magnetic modeling was applied to obvious magnetic anomalies in forearc areas of the Tohoku region, northeastern Japan. As many anomalies correspond to the Kitakami plutons, Cretaceous granitic bodies with high magnetic susceptibilities, rock magnetic properties were used for the modeling as constraints. A magnetic model southwestern edge of the Kitakami massif indicates a concealed Sobanokami pluton bounded to the west by the Ishinomaki-wan fault, the upward extension of the focal fault of the 2003 northern-Miyagi earthquake, implying an existence of a major geologic boundary and its successive activities. Another similar modeling was applied to magnetic anomalies associated with the Neu pluton, one of Cretaceous to Paleogene granitic bodies in the Chugoku region, southwestern Japan. Granitic rocks which constitute these plutons are known to show high magnetic susceptibilities as those of the Kitakami plutons. The 2000 western Tottori earthquake with M 7.3 hit the neighborhood and caused severe damage to buildings as well as many injuries. As aftershocks of the earthquakes were aligned to a northwest direction, a profile was set along the perpendicular to the direction and 2.5 dimensional modeling was conducted with rock magnetic data as constraints. The resultant model shows the thickness of the pluton increases from the boundary to the center and the seismicity related to the earthquake concentrated under the bottom of the pluton close to the thickest part. Electromagnetic surveys indicates the area is underlain by a conductive layer, suggesting the existence of crustal fluids. This implies the earthquake occurred by interactions between the pluton and crustal fluids.

Keywords: aeromagnetic anomaly, seismogenic region, petrophysical data

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

JAS012 **Oral Presentation** **604**

The features of geomagnetic induction arrows at two sides of Red river fault

Prof. Hao Truong Quang Hao
Geomagnetism, Intitute of Geophysics Hanoi Vietnam Institute of geophysics, VAST IAGA

The concept of induction method was original longtime ago introduced by Parkinson and Wiese and is largely used in the World. The method is very effective in the determination the canals having high electric conductivity in the Earth. Observing the geomagnetic variations of bay-like fluctuations with period from ten minutes to two hours at the territory of Vietnam we found the difference in the variations of components Z at Phuthuy(Hanoi) and at Sapa observatories: They are always in the opposite phases. The character of phase opposition in the variation of Z components occurred even at Xuangiao and at Phorang which are not far from each other (10-15 Km)but on the two sides of the Red River. At that time the difference of variations of H component are almost similar at these fours stascriptions. For D component we found the similar character as for H component. Using geomagnetic bay like variations at Sapa, Xuan giao,Phorang,Yenbai,Viethung, Phuthuy, Chuatram and Hoabinh we construc ted induction arrows for these locations. By following the directions of magnetic induction arrows, the region of high electrical conductivity at the faults of Red River can be detected.It is located in the upper flow of Red River from Phorang to bondaries Vietnam China(about 20 km).The longitudinal conductivity G(product of conductivity and cross sectional area) of the anomalous body by using the empirical relation given by Rokiyansky(1982)are estimated.

Keywords: geomagnetic induction, red river fault

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

JAS012 **Oral Presentation** **605**

Trans-cratonic kimberlite clusters, geomagnetic anomalies and superplumes

Dr. Saurabh Verma
Geophysical Exploration and Modeling National Geophysical research Institute, India IAGA

Study of the thickness of magnetic crust derived from long wavelength geomagnetic anomalies reveals that regions with large thickness lie over the cratons with known clusters of kimberlites. This is found to be valid for the Aravalli, Bastar, Singhbhum and Dharwar regions in India that host over 100 kimberlites of Proterozoic age. Most of these kimberlites occur at the flanks of the regions showing thick magnetic crust. It is interesting to find a similar correlation for the Proterozoic kimberlite clusters in , Central Africa, and Eastern Brazil . This observation suggests a possible link between the causative sources for kimberlites and regional geomagnetic anomalies. To a large extent this can be explained by the superplume activity experienced by the supercontinent Rodinia during the Proterozoic time. Rodinian reconstruction of various diamondiferous cratons and a smooth transcratonic distribution of regional geomagnetic anomalies provide further supportive evidence. The study has significant implications in identifying regions with potential for the occurrence of diamonds.

Keywords: magnetic crust and kimberli, kimberlites in rodinia, plumes, magnetic anomalies

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

JAS012 **Oral Presentation** **606**

New aeromagnetic view of the Wilkes subglacial Basin (East Antarctica)

Dr. Fausto Ferraccioli
Geological Sciences Division British Antarctic Survey IAGA

Egidio Armadillo, Jordan Tom, Emanuele Bozzo, Hugh Corr, Giorgio Caneva, Carl Robinson

The Wilkes Subglacial Basin (WSB) is an over 1,000 km long subglacial depression buried beneath the over 3 km thick East Antarctic Ice Sheet. It lies in the hinterland of the Transantarctic Mountains (TAM), the longest and highest rift-related mountain belt in the world. Little is known about this subglacial basin, owing to ice cover and to the significant logistic challenges, which geophysical exploration faces over this remote and hostile region. Understanding the sub-ice geology and crustal architecture of the WSB is however crucial to improve upon tectonic models for the TAM. In addition, uplift of the TAM and downwarp in the WSB could potentially be coupled to the "greenhouse-to icehouse" transition, and to the later Neogene stability for this part of the East Antarctic Ice Sheet. During the 2005-06 austral summer a major collaborative UK-Italian aerogeophysical survey was flown over the WSB and over the adjacent tectonic blocks of the TAM. A British Antarctic Survey Twin Otter, equipped with airborne radar, aeromagnetic and airborne gravity sensors was utilised to fly the survey from several bases and remote field camps supported by the Italian Antarctic Programme. Over 60,000 line km of new data were acquired, referring to an area of over 750,000 square km. This represents the largest integrated airborne geophysical survey performed so far over this region. In this presentation we will focus primarily on the analysis of newly detected aeromagnetic patterns for the WSB. However, as part of the interpretation process we also compare aeromagnetic signatures with the new bedrock topography map, as derived from airborne radar and with Free-Air, Bouguer and isostatic residual anomaly maps, which were obtained from the new airborne gravity dataset. The new airborne radar data revels that the WSB is not simply a single broad subglacial depression in the hinterland of the TAM. Instead, it is formed by several discrete subglacial basins, separated by prominent sub-ice mountain ranges and possible plateau features. The aeromagnetic anomaly data is used to analyse geology and to assess the possible tectonic controls on these newly discovered sub-basins. Aeromagnetic lineaments are detected utilising a combination of pseudo-gravity, tilt derivative and Euler Deconvolution maps. These maps strongly suggest the presence of fault-controlled sub-ice basins. This is at odds with a simple flexural origin for the WSB, suggested from several previous geophysical models derived from sparser land-gravity and bedrock topography data. By combining depth-estimates of magnetic anomaly sources with forward modelling, we also re-address the possible presence of sediments in the WSB, which is one of the centerpieces for the debate on the past, present and future stability of this part of the East Antarctic Ice Sheet.

Keywords: antarctica, aeromagnetics, geology

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

JAS012 **Oral Presentation** **607**

Aeromagnetic anomalies revealing the presence and age of Carbonatite complexes in north-eastern India

Dr. Venkata Ram Babu Hari
National Geophysical Research Institute Council of Scientific & Industrial Research IAGA

Aeromagnetic anomaly over a known Carbonatite complex in north-eastern India posess a predominant low towards the south with a small high to its north, revealing the presence of remanance. Such typical aeromagnetic anomalies in surrounding areas proved to be Carbonatite complexes. A few more anomalies of such type needs geological ground truth. The paleo-latitude computed from magnetic anomalies reveal that this part of the Indian sub-continent is loacted at about 30 degrees south latitude, closely corraborating with the break up history of the Indian sub-continent during the Jurassic period. The geochronological age for a Carbonatite of this type is about 115 Ga.

Keywords: aeromagnetics, carbonatite, remanant magnetism

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

JAS012 **Oral Presentation** **608**

Aeromagnetic evidence for a major fault belt at the transition between the Transantarctic Mountains and the Wilkes Subglacial Basin

Dr. Egidio Armadillo
DIPTERIS Universita' di Genova

Fausto Ferraccioli, Andrea Zunino, Emanuele Bozzo

The Transantarctic Mountains (TAM) form the highly uplifted and glaciated rift flank of the West Antarctic Rift System. Major faults exposed over the TAM in Northern Victoria Land were active during the Early Paleozoic Ross Orogen, while Cenozoic reactivation of some of these faults has been proposed from seismic and geological data. Aeromagnetic investigations provide a geophysical tool to trace some of these fault systems from outcrop areas across glaciated regions over Northern Victoria Land. Interpretation of aeromagnetic data has also been used to assess relationships between tectonic segmentation of the TAM and the inherited Ross-age structures. However, one of the key open questions regards the extent (if any) of this major fault belt under the adjacent, but entirely ice-covered hinterland of the TAM. The main morphological feature in this region is the Wilkes Subglacial Basin (WSB): it is a 1250 km long sub-ice basin, which was first detected by reconnaissance airborne radio-echo sounding and land-gravity data. Any tectonic relationships between the TAM, the WSB and the West Antarctic Rift System, remain poorly constrained due to the lack of extensive geophysical exploration, in particular over the WSB. The origin of the basin remains both enigmatic and controversial: it may represent an extensional basin, a flexural basin or possibly a transtensional feature. During the 2003-04 Antarctic field season the Italian Antarctic Programme performed a new aeromagnetic survey along part of the eastern margin of the Wilkes Subglacial Basin to provide a window on possible sub-ice structures lying between the Transantarctic Mountains and the basin. The resulting aeromagnetic anomaly maps image a set of NW-SE oriented aeromagnetic lineaments, interpreted as major sub-ice faults along the eastern margin of the basin. The presence of these faults along the margin of the basin makes a simple flexural origin for this part of the basin unlikely. Upward continuation enhances a long-wavelength magnetic high within the basin. It is similar to the magnetic high previously detected over the Prince Albert Mountains, where it marks an Early Paleozoic magmatic arc, emplaced along a buried fault zone. This fault zone, dubbed the Prince Albert Fault System, was previously hypothesised to represent the buried continuation of the Exiles Thrust, exposed 400 km further north, in Oates Land. However, the new aeromagnetic data rules this hypothesis out. Maximum horizontal gradient of pseudo-gravity, tilt derivative and Euler Deconvolution are used to compile a new tectonic elements map. This new map suggests that the Exiles Thrust-Matusevich Fracture Zone, links via complex fault splays to the Priestley Fault, exposed at the Ross Sea Coast.

Keywords: aeromagnetic map, faults, modeling

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

JAS012 **Oral Presentation** **609**

Differential magnetic measurements - a new tool for volcanic hazard prediction ?

Mr. Robert Supper
Department of Geophysics Geological Survey of Austria IAHS

Bruno Meurers, Christian Stotter, Shigeo Okuma

Traditionally airborne magnetic surveys are used for mapping regional geological features, fault zones and to produce a magnetic model of the volcanic subsurface.Within recent years an new magnetic anomaly map of the EolianIslands, Sicily, has been compiled. After applying certain steps of reduction (topografic correction, field transformation) important regional structural trends can be derived from the alignment of the residual magnetic anomalies. With respect to volcanic risk mitigation, we focused our research on repeated magnetic measurements.Temporal magnetic field variations in volcanic areas can be caused by changing size of the magma chamber or general rise in temperature. This effect is caused by the fact that magnetization disappears, when rock is warmed up over a certain temperature (Curie-temperature). In consequence the magnetic field reduces. Consequently, determining areas with changing magnetic field will help to select areas where a possible renewal of eruptive activity could be expected. High resolution airborne magnetic data, measured on the same flight lines, are available for the years 1999, 2002 and 2004 for the Vulcano-Lipari complex, collected by the Geological Survey of Austria with additional financial contribution from the Geological Survey of Japan. In addition, results from a magnetic survey, implemented by Agip in the year 1985, are available. Temporal field variations can be determined by comparing the results of different surveys. However, as both horizontal and vertical coordinates differ between the magnetic data sets of different surveys, data interpolation in 3D is the key issue. An effective way to compare the data sets obtained on different levels is the method of field-continuation between irregular surfaces. Previous investigations have shown that the method by M. Ivan (1994) represents a very suitable tool and has been implemented for the use of unevenly scattered data. This method was be improved, tested and applied to the Vulcano magnetic data sets to produce the first maps of changes of the magnetic field for the Volcano-Lipari area.Within this talk,recent developments, guidelines and limitations for producing magnetic difference maps will be discussed, based on model calculations and the results from Vulcano and Campi Flegreii data sets.

Keywords: magnetics, airborne, prediction

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

JAS012 **Oral Presentation** **610**

Distinctive deep magnetic highs in northwestern North America (Canada and Alaska): Indicators of deep crustal strength and structure?

Dr. Richard Saltus
IAGA

Mark Pilkington

Broad-scale, high-amplitude magnetic anomalies are important and distinctive features of the continental crust. Along the inboard margin of the Cordillera in and Alaska , detailed interpretation of a number of spectacular examples can be constrained, at least in part, by available deep seismic and other geophysical data. Several of these distinctive magnetic anomalies correspond to geometric changes in the thrust-front transition from the mobile belt to stable cratonic North America . The broad magnetic anomalies indicate massive amounts of mafic material at temperatures below the Curie point in the mid and lower crust. This mafic-rich lower crust is expected to be mechanically strong and highly competent, forming a buttress against craton-ward deformation of the Cordilleran mobile belt. The presence of massive amounts of mafic material in the lower crust may also imply geochemical depletion of the underlying upper mantle, which may serve to strengthen it against thermal erosion by upper mantle convection. Thus, the broad magnetic anomalies may be fundamental indicators of deep crustal (and perhaps upper mantle) strength and structure. These anomalies may indicate crustal zones where physical properties of the deep crust (and upper mantle?) influence the response to tectonic forces.

Keywords: magnetics, geophysics, tectonics

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

JAS012 **Oral Presentation** **611**

Application of magnetic method in the interpretation of structural pattern of the upper jurassic carbonate buildups in the Cracow-Czestochowa upland, South Poland

Mrs. Joanna Je Drys
Geology,Geophysics and Environmental Protection University of Science and Technology, Cracow

The Cracow-Czestochowa Upland (CCU) in south extends over the length of ca. 160 km and the average width of 20 km, and is built mostly of the Upper Jurassic carbonate deposits. The main geographical units within the CCU differ from each other in the nature of its relief, controlled by the facies variations within the Upper Jurassic deposits. The limestones occur in three main facies type: platy, bedded and massive, which represent carbonate buildups and interbiohermal deposits. One of the key problems of the geology of the CCU is the genesis of facial differentiation of the Upper Jurassic deposits. The facial distribution of the Upper Jurassic deposits depended on several factors, among whose the most important are: configuration of the north part of the Tethyan shelf, geological structure of the Palaeozoic basement and probable Late Jurassic synsedimentary tectonics. The Upper Jurassic deposits together with the locally present Permian and Triassic ones form the sedimentary cover of the Palaeozoic Central European Platform. A major fault zone in the CCU Palaeozoic basement - the Cracow-Lubliniec Fault Zone (CLFZ) - forms a boundary between the Upper Silesia and Malopolska terraine-like blocks. Along the CLFZ occur numerous intrusions of granitoids, porphyry, andesite, ryodacite, diabase, gabbro and others. The aim of the research was to check the hypothesis of the genetic connection of the Upper Jurassic carbonate buildups complexes with the presence of the igneous rocks intrusions in the Palaeozoic basement. To achieve this aim, the magnetic method was applied in order to determine the igneous rocks intrusions. On the magnetic anomaly map DT of the CCU occur positive regional magnetic anomaly zones of two types: in the north part they have 2D character and in the south 3D character, both of which conclude few local anomalies. The detailed interpretation of the magnetic anomalies, which based on the borehole data, field observations and results of the gravity anomalies interpretation, allowed the sources of the magnetic anomalies to be determined. These are intrusions of igneous rocks, mostly in the form of batholites and smaller intrusions of lower rank, and connected with them: mineralization and series of metamorphically changed sedimentary rocks. According to modelling, the bottom of the batholites reaches the depth of ca. 3 km and the tops of the shallowest intrusions ca. 500-700 m. A comparison of the interpreted locations of the intrusions in the Palaeozoic basement with the regional distribution of the Upper Jurassic carbonate buildups complexes on the CCU reveals a distinct coincidence. Thus the application of the magnetic method allowed understanding of the structural pattern of the Upper Jurassic carbonate buildups in the CCU.

Keywords: magnetic anomaly, carbonate buildups, upper jurassic

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

JAS012 **Poster presentation** **612**

Recontruction and prediction fault using paleomagnetic methode

Mr. Suaidi Ahadi
Geomagnetic BMG Indonesia IAGA

Ken Wirawan, Margono, Hasanudin, Roy Tulus G

Aceh Quake on December 26,2004 was nightmare in history earthquake and Tsunami at Indonesia, this was The Big Earthquake which event. Cause from earthquake result fault with long 1000 Km direction East South as follow Aceh to Andaman. The Fault was very phenomenon in the century because have big tsunami. Paleomagnetic is a Methods Geomagnetic for de or reconstruction last event or next event geomagnetic variation with using time series data statistic method. At the research would be reconstruction Andaman-Aceh Fault using Paleomagnetic. The reconstruction will result when the fault system shape, direction of formed fault?, the next we will know where direction fault system Andaman-Aceh for precursor earthquake in the future

Keywords: paleomagnetic, fault system, tsunami

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

JAS012 **Poster presentation** **613**

Modelling and Interpreting Oceanic Lithospheric Magnetic Field Anomalies using CHAMP Satellite Data

Mrs. Sheona Masterton
Earth Sciences University of Leeds IAGA

Kumar Hemant, David Gubbins

High resolution lithospheric magnetic field anomaly maps derived from CHAMP satellite data now offer immense opportunities to interpret anomalies observed over oceanic regions in terms of crustal properties such as susceptibility, thickness, magnetisation type and heat flow. The present work aims to determine these properties and improve understanding of their variation across younger to older oceanic regions; this includes the study of a change in anomaly character at ~84 Ma, which may be attributed to a transition from remanent- to induced- dominant magnetisation acquired during the Cretaceous Normal Superchron. A crustal magnetisation model is derived using a GIS-based forward modelling technique. A vertically integrated susceptibility (VIS) model is first computed for all oceanic regions; input comprises a three-layered crustal thickness model, the major rock types and associated standard susceptibility values. A remanent vertically integrated magnetisation (VIM) model is then derived by imposing a thermo-remanence decay and chemical remanence acquisition model on the digital isochron map of the ocean floor. The potential of the field due to induced and remanent magnetisation is then found using an equivalent dipole method. Spherical harmonic expansion of the potential allows prediction of magnetic anomaly maps which may then be compared with those derived from satellite observations.

Keywords: gis, geomagnetism, oceanic

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

JAS012 **Poster presentation** **614**

Three-dimensional magnetic and gravity inversions in and around Iwo-Jima Volcano

Dr. Ryuji Kubota

The idea of a geomagnetic tomography by modeling a three-dimensional body with layered and segmented blocks, which have variable magnetization intensities, was first applied to the Quaternary volcano of Miyake-jima island in Japan by Ueda et al. (2001). This method was based on a simple linear inverse theory. In this paper, we further expanded this method to the three-dimensional gravity inversion to obtain non-uniform density modeling about the active volcano. The structure of a volcano was divided into many blocks modeled by layered and rectangular prisms, and parameters were assigned to each block describing the density fluctuation from the average one which was corresponding to the density for the terrain and Bouguer corrections. The three-dimensional magnetic and gravity inversion methods were applied to data observed by the JHOD in and around Iwo-jima volcano situated on the Shicito-Iwojima Ridge. These inversion studies revealed that the central portion of Iwo-jima volcano was composed of a non-magnetization and low density blocks, and almost all the blocks surrounding the central portion showed high magnetization and high density. These results were consistent with the results of three-dimensional magnetic model (Oshima, 1985) and two-dimensional gravity model (Ueda, 1985) by using Talwanis method. 1. JAS012 2. Seismological, geological and tectonic interpretation of geomagnetic anomalies on continents and oceans 3. magnetic inversion, gravity inversion, active volcano. 4. Dr. Ryuji Kubota, Technical Research Center, Kawasaki Geological Engineering Co., Ltd., 2-11-15 Mita, Minato-ku, Tokyo 108-8337 JAPAN, E-mail:kubotar@kge.co.jp 5. P 6. NO 7. NO 8. Ryuji Kubota: NO, Ken-ei Onodera: NO 9. NONE

Keywords: magnetic inversion, gravity inversion, active volcano

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

JAS012 **Poster presentation** **615**

Integral and differential analysis metods of the magnetic field from MAGSAT, CHAMP satellite data.

Dr. Andrey Kharitonov
Satellite Geomagnetic Research Laboratory IZMIRAN IAGA

Fonarev Gennadiy, Kharitonova Galina

Practically all the methods for the solution of forward and inverse problems of the anomaly magnetic field are based on the results of integral or differential methods and in certain, spectral analysis. The wavelet transform permits not only to identify characteristic features in a spectrum, but, also, to observe their changes in time or in space. In other words, the wavelet transform provides a two-dimensional (2D) distribution of the series under investigation with independent values of its scale coefficient and coordinate. Today, this method finds very extensive application in the analysis of experimental data, because its basis is local and the time-and-frequency window is moveable. Thus, the results of spectral analysis, as well as of the wavelet transform of the magnetic anomaly profiles from the MAGSAT, CHAMP satellite measurements has demonstrated their complex structure in space; several classes of long-wavelength anomalies are identified with different spatial dimensions. The structure of the coefficients of the wavelet transform permitted not only to reveal characteristic scales of spatial heterogeneities in the anomaly field, but, also, to show their localization at the longitudinal profile. It has been also found that the dynamics of such fields is determined predominantly by small-scale values of the parameter a. The activities in the field of differential magnetic measurement from satellites CHAMP and МАГСАТ were continued. An apart from of refinement of an anomalous field of Kursk magnetic anomaly the area of subsinusoidal anomalies presumably connected to a magnetic non-uniformity of an African rift system was detected. The differential magnetic measurements (DMM) in MAGSAT, CHAMP is alternative for indirect methods of the registration of long-wave variations needlessly of satellite spatial measurements (SWARM - satellite). The extraction of magnetic anomalies by two gradiental methods (with diverse towed magnetometers and DMM) increases confidence to outcomes of the interpretation. For filtration of the ionosphere part of measured magnetic field we used differential method.

Keywords: satellite, differential, measurement

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

JAS012 **Poster presentation** **616**

The geology structure imaging by aeromagnetic data inversion at the southeast margin of Bayankela block in Tibet plateau

Mr. Ruo Wang
Institute of Geology and Geophysics Chinese Academy of sciences IAGA

Miaoyue Wang, Qingyun Di, Guangjie Wang

The southeast margin of Bayankela Block in Tibet Plateau is a tectonic active area with serious rough topography. The internal tectonic forces caused by earth interior process and external forces caused by weathering are very strong. Some important engineering constructions are sited in this area. Therefore it is concerned that whether the hazards such as the natural earthquake, land sliding and suddenly unstable events during engineering construction will happen or not under such strong internal and external process. To answer such question one of the key knowledge has to be known is the detailed geological structures beneath the surface of this area. The paper is focus on discussing the fine magnetic structures obtained by the aeromagnetic data inversion result and the interpreted fine geology structures. The research area is located at the southeast margin of Bayankela Block in Tibet plateau. The range is from 98^{o} to 103^{o} in east longitude and from 31.5^{o} to 34^{o} in north latitude. The total area is about 15 million square kilometer. This is part of an active seismic belt and with moderate seismicity, and this is the area some significant hydraulic engineering will pass through, which makes the research has a definite object in view. The data is provided by China Aero Geophysical Survey & Remote Sensing Center for Land and Resources, where the geologist engaged in aeromagnetic surveying. Under the basis of surveying results, they compiled the unitized aeromagnetic data with scale 1:500000. The aeromagnetic data with scale 1:500000 in the research area are inverted by the linear inversion technique in 2D. The data include 476 profiles in north-south direction; the distance between two adjacent survey profiles is 1 km. There are 277 rectangular prisms with 1km width along a profile and 8 rectangular prisms with 4km height in vertical direction during the inversion scheme. The inversion results of all of the profiles constitute the 3D inverted relative magnetism data, from which four horizontal relative magnetism slices in the depth 5.5km, 17.5km, 21.5km, 29.5km and seven vertical slices in northeast direction are obtained separately. With the published geology and geophysics references, the geology structure meaning of the magnetic fine structures is discussed here. We find that the fine magnetism structures can provide more information for geology structures than that of the character of magnetic field itself can provide, especially, the result is helpful to infer the detail of the shape and extension of faults and lithology of rocks.

Keywords: bayankela block, aeromagnetic, tomography

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

JAS012 **Poster presentation** **617**

Magnetic characterization offshore North Tenerife Island: a decade perspective

Dr. Manuel Catalán
Royal Observatory Spanish Navy Researcher IAGA

Alicia Garca, Jos Martn-Davila, Nieves Snchez

Tenerife Island is the largest one of the Canary Archipelago. Although placed on to the north-western Africa continental passive margin, all islands but one have been active in the last million year. Four of them show a record of eruptions in the last five centuries. Particularly, Tenerifes latest eruptions took place in the 18th century (1704-05, 1706, 1798) and at the beginning of the 20th century (1909). On April 2004 the pattern of seismic activity at Tenerife suffered a significant change. This change was characterized by the occurrence of swarms of local earthquakes, tremors and volcano-tectonic earthquakes, concentrated in the North and North-Western part of the island. Some studies suggest a magma recharge at depth into the north-western rift zone of Tenerife which could have triggered a migration of fluids inside the complex. Nevertheless there is still some controversy concerning this issue. Anyway, a volcanic risk exists in the area and that is why it has been the subject of several geophysical marine campaigns, i.e.: TEIDE-95, Spanish Exclusive Economic Zone cruises: 1998, 1999 and 2000, TENERIFE-2005, and an aeromagnetic flight performed by the Spanish National Geographic Institute in 1993, among others. Fortunately, each campaign focuses specially on a particular area except for the 2005 cruise, which is more homogeneous from the spatial coverage point of view. Taking advantage of this fact, we have two kinds of pictures: one pre- and another syn- (or even post-) 2004 seismic crisis. These data set, at least potentially, could provide information about the complex magnetic distribution around this volcanic area, for which objective we have to be sure that our information presents the highest possible level of accuracy. This crucial aspect will be fully explained, as well as the methodology followed. Additionally, and using the whole data set, we have tried to provide an onshore/offshore magnetic characterization of the north of the island, trying to connect it with the main volcanic complex inside the island.

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

JAS012 **Poster presentation** **618**

Curie point depths of bulgarian territory inferred from geomagnetic observation

Mrs. Petya Trifonova-Rusinova
Geomagnetism and Gravimetry Geophysical Institute (BAS)

Zhelev Zheljo 1, Petrova Totka 1, Bojadgieva Klara 2

Generally, geomagnetic data are used for extrapolating of magnetic rocks in the covered areas and interpolating of subsurface lithotectonic features between the more widely spaced seismic profiles. In this paper we examine the spectral properties of the geomagnetic field to infer depths to the Curie point temperature and to relate it to other geological information. As is known, crustal rocks lose their magnetization at the Curie point temperature, become paramagnetic and their ability to generate detectable magnetic anomalies disappears. The method allows determination of the depth at which the magnetite passes from ferromagnetic to paramagnetic state under the effect of increasing temperature. The Curie temperature for titanomagnetite, the most common magnetic mineral in igneous rocks, is approximately 580oC. Consequently, it may be possible to locate a point on the isothermal surface by determining the depth to the bottom of a magnetized rock mass. In certain approximation, adequate for the inverse problem solution, this surface could be marked as Curie temperature isotherm. One of the important parameters which determine the relative depth of the isotherm with respect to sea level is the heat content in a particular region. It is therefore to be expected that a region having significant geothermal energy near the surface of the earth will be associated with a conspicuously shallow Curie point isotherm, relating to the adjoining regions. Estimates of the Curie point depths should be treated with caution for both mathematical and geological reasons. First, because these calculations encompass the nonuniqueness of the inverse problem solution and second, the basal depth of magnetic sources may not be an isothermal surface because rock magnetic properties, and the Curie temperature, in particular, may vary due to mineralogic changes. Bearing these concerns in mind, a spectral analysis technique was applied to the compilation of geomagnetic data from Bulgaria to estimate the basal depth of magnetic sources. The results obtained from Curie point depth estimation of Bulgaria vary in a relatively wide range - from 17 up to 34km. Generally, a wide zone could be determined, having values between 28 and 32km in depth. On this background, several anomalous regions are delineated and compared with other geological information concerning the distribution of temperatures in depth (e.g. geothermal activity, tectonic investigations).

Keywords: geomagnetics, spectrum, geothermal

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

JAS012 **Poster presentation** **619**

Tectonics of Guhaghar area of Maharashtra: a case study based on electromagnetic and ground magnetic data

Dr. Vinit Erram
Solid earth Geophysics Solid Earth Geophysics IAGA

Gautam Gupta, B.N. Umrikar, S.S. Thigale

Morphometric data of the Konkan coast region of Maharashtra reveals the presence of a number of NNW-SSE trending fractures. One of the prominent fractures, as clearly depicted from satellite imagery is seen to be developed from the Vashishti in the North to the Shastri river in the South. In order to delineate the fractures and fault zones and to ascertain their depth, electromagnetic and ground magnetic studies have been carried out in the Guhagar and Chiplun region. The electromagnetic data collected in and around Shringar Tali is indicative of increasing magnitude of fracturing from source to down stream. The imaginary curves are subdued in comparison to real part of the curve, which may manifest presence of fresh water within the fracture. The ground magnetic data revealed the presence of some fractures parallel to the Arabian coast; prominent amongst them are at Shringar Tali and Rampur, having a depth of 2.5 and 2.8 km respectively. It has been inferred that these fractures penetrate through the basaltic and the Dharwarian rocks and form a part of the fracture system-paralleling fault.

Keywords: electromagnetic survey, coastal tectonics, ground magnetic survey

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

JAS012 **Poster presentation** **620**

Helicopter-borne Aeromagnetic Survey over Sakurajima Volcano, Kyushu, Japan.

Dr. Ayako Okubo
Geophysics Research Group Geological Survey of Japan, AIST IAGA

Yoshikazu Tanaka, Wataru Kanda, Kazuhiro Ishihara, Daisuke Miki, Mitsuru Utsugi

In November, 2005, we conducted helicopter-borne aeromagnetic surveys at about 250m above the terrain over Sakurajima Volcano, Kyushu. We applied the apparent magnetization intensity mapping method to the newly obtained aeromagnetic data assuming that the magnetization intensity varies only laterally. Results showed following features: (1) Apparent magnetization highs predominate on the eastern region of Sakurajima, where thicker lava flows occupied, compared with the western region of Sakurajima. (2) Apparent magnetization intensities of lava flows were from 4.0 to 7.0 A/m. The most remarkable highs (> 6.0 A/m) were located on the lava around An'ei craters and on the northeastern flank of Kita-Dake summit. (3) Magnetization lows (< 1.0 A/m) are locally distributed around the Showa crater, suggesting a high temperature in the shallow part. In addition, magnetization lows (< 3.0 A/m) lie over the northern slope and over the northwestern area of Kita-Dake which are likely to reflect debris flow deposits and volcanic fans. To examine the validity of the obtained map, we carried out rock-magnetic studies. The total magnetization intensities for the surface-rocks showed reasonable correlation with the mapped values.

Keywords: aeromagnetic survey, sakurajima volcano, mapping

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

JAS012 **Poster presentation** **621**

Gulf of Cadiz airborne magnetic survey

Dr. Isabel Socias
servicio geomagnetismo instituto geografico nacional IAGA

Armand Galdeano, Javier Pavon

The aeromagnetic survey of the Gulf of Cadiz was carried out by the IGN during 2005. The main purpose of it was to have a better knowledge of this area, one of the most important tectonic ones in the Iberian region. The survey was flown at 700 meters above sea level, with a flight a tie-line spacing of 10 and 40 kilometres respectively, covering approximately 16000 line kilometres. The Magnetic Residual Field was obtained after filtering, processing and levelling, resting the corresponding IGRF.A preliminary interpretation of these data at flight altitude shows structures already known and clearly appears a big alienation going from Gorringes Bank to enter in Northern Morocco, separating zones of very different magnetic textures. Magnetic continuation of the main structures has been achieved by joining these data with the Iberian Peninsula and Alboran Sea ones, at 3000meters altitude. This union allows having a better global knowledge of the external Betics, the Gibraltar arc and the extension of the Alboran Sea. The main alienations and discontinuities as well as some other structures, are drawn, showing the important tectonic processes that have taken place in this area.

Keywords: magneticanomalies, gulfofcadiz, iberia

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

JAS012 **Poster presentation** **622**

Long-wavelength geopotential fields study in East Asia from satellite data

Dr. Patrick Taylor
Earth Science NASAGSFC IAGA

Jong Sun Hwang, Gest, Jan Kutina

Kutina et al. (2006) proposed the existence of a large fracture zone extending from northern China across the Yellow sea, Korean peninsula, sea of Japan and on to Honshu Island, Japan, which they termed the 'Forty-North Fracture Zone." In order to investigate this proposed large tectonic feature we used the GRACE and CHAMP satellite potential fields data to make large-scale regional gravity and magnetic anomaly maps. The regional study area extended from 24o to 56o north latitude and 90o to 150o east longitude with the local area from 32o to 42o north latitude and 122o to 132o east longitude. The anomaly maps were made from CHAMP magnetic data recorded between June and December 2005 and the gravity from October 2003. We constructed the magnetic anomaly maps directly from track measurements to enhance the spatial resolution. To construct the magnetic anomaly field we removed the main (IGRF-10, Macmillan and Maus, 2005), external fields (Kim et al., 2002), reduction these data to the pole. A mathematical model was constructed and interpreted using available geologic and geophysical information. The zero contour line of this anomaly map divided this peninsula into two parts with most of the recent earthquakes (since 1905, Lee and Yang, 2006) occurring to the south (Taylor et al., 2007). The gravity anomaly field was made from the GRACE data converted from potential differences to vertical gravity anomalies by using Gauss-Legendre quadrature inversion. Long wavelengths (>500km) were removed by subtracting the latest EGM96 field. There was a signal of a latitudinal anomaly trends in both gravity and magnetic observations. These fields showed inverse correlation and supports the existence of the 'Forty-North Fracture Zone' in the East Asian region.
References:Kim, H. R., R.R.B. von Frese, J. W. Kim, P. T. Taylor and T. Neubert, 2002, rsted verifies regional magnetic anomalies of the Antarctic lithosphere, 29 (15), doi:10.1029/2001GL013662, 2002 ; Kutina, J., S. Cui, R. Pei and M. Jiang, 2006, A deep-seated E-W trending structural boundary indicated as extending across the Korean Peninsula at a latitude close to 40o N, Global Tectonics and Metallogeny, 9 (1-4), in press, after proofs; Lee, K and W. -S. Yang, 2006, Historical Seismicity of Korea, Bull. Seismological Soc. Amer., 96 (3),846-855; Macmillan, S. and S. Maus, 2005, IGRF-10th generation, EPS, 57(12), 1135-1140; Taylor, P.T., H.R. Kim, J. Kutina, and G.L.Johnson, 2007, Geohazard Assessment from Satellite Magnetic

Keywords: geopotential, seismicity, tectonics

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

JAS012 **Poster presentation** **623**

Detection of aeromagnetic anomaly change associated with volcanic activities - Application of generalized mis-tie control

Dr. Tadashi Nakatsuka
Institute of Geology and Geoinformation Geological Survey of Japan, AIST IAGA

Mitsuru Utsugi, Shigeo Okuma, Yoshikazu Tanaka, Takeshi Hashimoto

Aeromagnetic survey is expected to contribute to the elucidation of the volcanic structure and the change of its activity. However, the track lines of repeated surveys cannot be the same, and the inspection to the repeatability and the spatial alias effect of magnetic anomaly pattern is quite important to acquire valid information of the activity, especially in case of high resolution survey in mountainous area where low altitude flights are conducted along rugged terrain. To overcome this difficulty, we investigated the method of retrieving the magnetic anomaly change. We applied a technique of generalized mis-tie control, and it was proven that the spatial alias effect could be mitigated by this technique (Nakatsuka and Okuma, 2006). This method was applied to actual data of Asama Volcano 2005 survey. Asama Volcano EM Field Experiment Group conducted the survey in October, 2005 (Utsugi et al., 2006). The existing reference data was the survey by the Geological Survey of Japan in 1992, published as the High-resolution Aeromagnetic Anomaly Map of Asama Volcano (Okuma et al., 2005). The year 1992 is situated in the midway of Asama activities in 1982-83 and in 2004, and the 2005 survey was soon after the 2004 activity. In the 1992 survey, survey lines of 150m spacing with terrain clearance of 200m were flown, while the observation surface of 2005 survey is selected to be of calm slope at the altitude of 2000-2500m ASL, much higher than 1992 survey in mountain foot areas. Both data revealed similar magnetic anomaly pattern as a whole, indicating no drastic structural change during these years. The result of our analysis of generalized mis-tie control revealed the decrease of magnetic anomaly value at summit area, the increase in the SE part of Yunotaira, and the irregular disturbances around Kengamine-Kibayama-Yunotaira region. There still remains an uncertainty because of limited positioning accuracy in 1992 survey when the GPS was not fully available, and further studies are expected.

Keywords: magnetic anomaly change, volcanic activity, mis tie control

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

JAS012 **Poster presentation** **624**

Tracing a Cenozoic magmatic province over the Transantarctic Mountains with aeromagnetic anomaly data

Dr. Egidio Armadillo
DIPTERIS Universita' di Genova

Fausto Ferraccioli, Andrea Zunino, Emanuele Bozzo, Pietro Armienti, Sergio Rocchi

The continental-scale, ice-covered West Antarctic Rift System (WARS) extends from the Ross Sea, beneath the Ross Ice Shelf and the West Antarctic Ice Sheet.The WARS is characterised by bimodal igneous activity from 48 Ma to the present.In northern Victoria Land plutons (48-23 Ma), dyke swarms (47-35 Ma), and volcanoes (15 Ma-present) are exposed over an area of about 200 x 80 km along the West Antarctic Rift flank. Previous aeromagnetic surveys have imaged large alkaline intrusive complexes known as the Meander Intrusives between Mariner Glacier and Campbell Glacier, because of their discrete, high-amplitude near-circular magnetic signature. This area may correspond to a major tectonic block of the Transantarctic Mountains, namely the Southern Cross Block. The lack of comparable magnetic signatures south of Campbell Glacier suggests that the Campbell Fault may mark the southern boundary of this Cenozoic alkaline intrusive province over this segment of the Transantarctic Mountains. Similar anomalies have however been recognised to the south beneath the Ross Ice Shelf, perhaps associated to a transfer fault within the West Antarctic Rift. However, the north-eastern extent of these intrusive complexes is presently unconstrained from a geophysical perspective. The northernmost outcrop of these Cenozoic intrusions recognized so far is the Cape Crossfire Igneous Complex, which lies between Mariner Glacier and Borchgrevink Glacier.During the 2001-2002 Italian Antarctic campaign, an aeromagnetic survey was performed north of Mariner Glacier. The new survey aims at investigating if the Meander Intrusives continue in the highly uplifted Admiralty Mountains block, or if there is a tectono-magmatic segmentation of the Transantarctic Mountains, such as observed across the Campbell Glacier. This region is a missing piece to better understand relationships between the geodynamic evolution of the Transantarctic Mountains, the Ross Sea Rift System and alkaline magmatism.Standard aeromagnetic data processing procedures were implemented with microlevelling techniques in frequency domain. The data were also draped over the bedrock to account for varying distance to source. Our new enhanced aeromagnetic maps for the region address the northern extent of the Cenozoic alkaline plutons and volcanics in northern Victoria Land. We focus upon the spatial distribution of these rocks in relation to inferred intra-plate strike-slip fault belts, which have recently been proposed to control magma genesis and emplacement, as opposed to the classical plume model for this Cenozoic igneous province.

Keywords: aeromagnetic map, alkaline intrusive complexes

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

JAS012 **Poster presentation** **625**

Magnetic anomaly field for Europe and Western Siberia regions from CHAMP satellite data

Dr. Abramova Daria Yu.
Institute of Terrestrial Magnetism, Russian Ac. Sc Research Scientist IAGA

MAGNETIC ANOMALY FIELD FOR EUROPE AND WESTERN SIBERIA REGIONS FROM CHAMP SATELLITE DATA DARIA ABRAMOVA Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation , Russian Academy of Science, IZMIRAN, Troitsk, Moscow reg., 142190, Russia. Since the time of the launch of Magsat has demonstrated a possibility of mapping the crustal magnetic anomalies at satellite altitude many studies based on satellite geomagnetic data were made for different regions of the Earth. In our investigation we use the initial data of the geomagnetic field recorded by the CHAMP satellite. The new original approach to the CHAMP geomagnetic data processing is proposed for the more correct extraction of the magnetic anomaly field. It includes a complex of modern mathematical methods and is based on the use of one-day reference field model constructed also from the CHAMP mission data. Using the developed program of allocation of geomagnetic field data from total amount of records obtained by CHAMP satellite the base of experimental data for 2 years period of its work is created for the territories of Central and the East Europe, Urals Mountains and Western Siberia. The classical approach to the anomaly potential magnetic field extraction from the satellite data, consisting in consecutive removal from the values of geomagnetic field, measured in an orbit, the parts, connected with various physical sources, is improved. It is offered to subtract daily spherical harmonic model of the main magnetic field, constructed also on the base of CHAMP data for the same day to which the examined satellite pass belongs, from experimental values of each pass selected for the further analysis. Using the above described technique of the division of experimental values of the geomagnetic field, received by satellite at height about 400 km, for several independent sets of satellite data it was constructed a distribution of an anomaly magnetic field for territory of East-European platform, area of Urals Mountains, Western Siberia and the Mediterranean zone. For regions of Far East coast of Pacific ocean and Northern Atlantic preliminary results are received. The presented spatial distribution of an anomaly magnetic field was found rather reliable and detailed in comparison with the previous investigations. In the limits of East-European platform we can find several positive anomalies of the vertical component which disposed in the outlying districts and one negative anomaly in the centre - the Centre Europe minimum. Satellite magnetic anomaly over Ural plicated zone is constituted of several maximuma. The most part of the young Western Siberia platform is associated with the area of negative and weak positive anomalies. The revealed regional magnetic anomalies find reflection in tectonic structure of considered regions though have no direct correlation with the modern geological structures (their site correlates with the seismic, thermal and other data about lithosphere). The reason of these anomalies formation can be the variations of temperature in homogeneous lithosphere layer or horizontal variations of the magnetic minerals structure, and also a combination of these two factors.

Keywords: anomaliy magnetic field, champ data

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

JAS012 **Poster presentation** **626**

Does the west antarctic rift system extend to the Amundsen Sea embayment region?

Dr. Fausto Ferraccioli
Geological Sciences Division British Antarctic Survey IAGA

Jack Holte, Tom Jordan, Don Blankenship, Theresa Diehl, Hugh Corr, Duncan Young, Scott Kempf, David Vaughan

The West Antarctic Rift System is often envisaged as a major lithospheric feature, perhaps comparable to the Basin and Range province of the U.S. Although the rift system is often portrayed on tectonic sketch maps as extending for about 3,000 km from the Transantarctic Mountains to the Ellsworth Mountains, at the base of the Antarctic Peninsula, the extent andgeodynamics of rifting is far from being well-constrained for many parts. Evidence for Cenozoic rifting is fairly well documented in the Ross Sea area and over the adjacent Transantarctic Mountains rift flank. It includes Cenozoic alkaline magmatism, faulting and uplift, crustal thinning, and rift basins, with several km thick-sedimentary infill. Drilling in the Cape Roberts rift basin, adjacent to the Transantarctic Mountains front, recovered sediments as old as 34 Ma. Marine geophysical data over the Adare Trough, adjacent to northern Victoria Land, suggests that a major phase of extension between East and West Antarctica (approximately 180 km) occurred in Cenozoic times. However, most plate-tectonic reconstructions favour an earlier phase of major extension across the Ross Sea region, likely associated to Cretaceous Gondwana break-up. Outcrops of Cenozoic rift-related magmatism are widely distributed over the Marie Byrd Land dome, where they are traditionally envisaged as being mantle plume-related. Large volumes of late Cenozoic(?) rift-related magmatism have been interpreted beneath the West Antarctic Ice Sheet over Central West Antarctica, by utilising aeromagnetic anomaly data. At least one active subglacial volcano (Mt Casertz) has been identified. However, a magnetotelluric profile suggests that the rift may in part be dormant. Airborne geophysical data has clearly imaged sub-ice sedimentary basins, including both linearnarrow rifts and broader low-lying areas of distributed extension over the Ross Sea Embayment (RSE), although the age of these features is uncertain. Cenozoic volcanism and rift-related sedimentary basins are spatially associated with the Siple Coast ice streams and may modulate the dynamic behaviour of this part of the West Antarctic Ice Sheet. However, are rift structures and associated volcanics widespread in the Amundsen Sea Embayment (ASE) region, where there is mounting evidence for thinning and retreating of major glaciers, such as Pine Island Glacier and Thwaites?. Receiver functions derived from seismological data yield crustal thickness estimates of 21 km in the Bentley Subglacial Trench region. This suggests that there has been at least locally extreme crustal extension. If rift-related features exist in the ASE, do they provide a geological template for enhanced glacial flow, as suggested for the RSE?. To address these two major open questions from a new geophysical perspective we will present aeromagnetic anomaly images resulting from a recent joint field campaign of the British Antarctic Survey and the University of Texas. The aeromagnetic anomaly data will also be compared to airborne gravity and airborne radar imaging for these regions.

Keywords: antarctica, aeromagnetics, rifting

Ward William	491
Kyzyurov Yurij	492
Beig Gufran	493
Lastovicka Jan	494
Sridharan Sundararajan	495
Meier Robert R	496
Batista Paulo	497
Krivolutsky Alexei	498
Kanukhina Anna	499
Cnossen Ingrid	500
Alfonsi Lucilla	501
Mlynczak Martin	502
Motoba Tetsuo	503
Zolesi Bruno	504
Sharma Som Kumar	505
Mohan Vyas Brij	506
Holt John	507
Barlyaeva Tatiana	508
Brasseur Guy	509
Reid Iain	510
Klimenko Vladimir	511
Barkin Yury	512
Barkin Yury	513
Chu Fangdar	514
Torta J. Miquel	515
Sharma Som Kumar	516

In collaboration with

UNIVERSITÀ PER STRANIERI • PERUGIA •

SVILUPPUMBRIA

Umbriafiere S.p.A.

CAMERA DI COMMERCIO INDUSTRIA ARTIGIANATO E AGRICOLTURA PERUGIA

Umbria
Agenzia Regionale
di Promozione Turistica

POST

PERUGIA SCIENCE FEST

Sponsored by

FONDAZIONE
CASSA RISPARMIO PERUGIA

Endorsed by

BANCA DI MANTIGNANA
CREDITO COOPERATIVO UMBRO
Vicini, per vocazione

CrediperCasa
Il mutuo su misura per te

apm
AZIENDA PERUGINA DELLA MOBILITA'
TI TRASPORTIAMO

OGS

LEONARDI
Istituti Superiori

ATHENEUM
PREPARAZIONE UNIVERSITARIA

EVERSUN
abbronzatura e centro benessere

Thanks to

ADiSU
Agenzia per il Diritto
allo Studio Universitario
dell'Umbria

Fondazione Accademia di Belle Arti
Pietro Vannucci - Perugia

GESENU
IGIENE AMBIENTALE

TCI
Touring Club Italiano

MiBAC
Archivio di Stato
di Perugia

CONSORZIO
PERUGIA
CITTÀ MUSEO

Media Partners

Rai
Sede regionale per l'Umbria

CORRIERE DELL'UMBRIA

IUGG
XXIV2007
PERUGIA
ITALY

Published and Distributed by

USMA 2007
Umbria Scientific Meeting Association 2007
c/o IRPI CNR
Via della Madonna Alta, 126 - 06128 Perugia - Italy
e-mail: protocol@iugg2007perugia.it
website: www.iugg2007perugia.it

Printed in Italy, March 2008