Perugia, Italy July 2-13, 2007

IAMAS

INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC SCIENCES

INTER-ASSOCIATION SYMPOSIA AND WORKSHOPS

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EARTH: OUR CHANGING PLANET

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Abbreviations

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

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

Session code naming

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

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

Some examples:

US002

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

MS003

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

JMS001 **Symposium** **(715 - 728)**

Convener : Prof. Richard Peltier

Our Changing Planet

JMS002 **Symposium** **(729 - 758)**

Convener : Prof. Guy Brasseur

Earth System Interactions

JMS003 **Symposium** **(759 - 841)**

Convener : Prof. James Drummond

Satellite Observations: Products and Applications

JMS004 **Symposium** **(842 - 845)**

Convener : Dr. Anne Thomson

Intercontinental Transport of Substances and its Consequences

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JMS005 **Symposium** **(846 - 882)**

Convener :
Co-Convener : Prof. Ulrike Lohmann, Prof. Zev Levin

Aerosols, Biomass Burning and Precipitation

JMS006 **Symposium** **(883 - 892)**

Convener : Dr. Valrie Masson-Delmotte
Co-Convener : Dr. Barbara Stenni

Glacial-Interglacial Cycles: New Records, Analyses, and Modelling

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Symposium **(893 - 902)**

JMS007

Convener : Dr. Kendal McGuffie
Co-Convener : Prof. John Gibson

Stable Water Isotopes: from Basin to Global Scale

JMS008 **Symposium** **(903 - 916)**

Convener : Dr. Tom Lachlan-Cope

Clouds and Radiation and Air-Sea-Ice Interactions

JMS009 **Symposium** **(917 - 975)**

Convener : Prof. Ronald Stewart

Hydrological Cycle, Precipitation and Precipitation Systems

JMS010 **Symposium** **(976 - 1005)**

Convener : Prof. Peter Baines, Prof. Roger Smith

Tropical Cyclones

JMS011 **Symposium** **(1006 - 1106)**

Convener : Prof. Guoxiong Wu

Monsoon Systems

JMS012 **Symposium** **(1107 - 1131)**

Convener : Prof. Darrell Strobel, Dr. Athena Coustenis
Co-Convener : Prof. Piergiorgio Casavecchia

Planetary Atmospheres and Their Evolution

Symposium **(1132 - 1170)**

JMS013

Convener : Dr. Dmitry Titov, Prof. Darrell Strobel, Dr. Athena Coustenis
Co-Convener : Prof. Piergiorgio Casavecchia

Aeronomy of Planetary Atmospheres: Comparative Planetology

JMS014 **Symposium** **(1171 - 1201)**

Convener : Dr. David Woolf
Co-Convener : Dr. De-Zheng Sun

Ocean-Atmosphere Coupling

JMS015 **Symposium** **(1202 - 1230)**

Convener : Prof. Christoph Schär
Co-Convener : Dr. Sonia Seneviratne, Prof. Stefan Brönnimann

Mid-latitude Droughts in a Changing Climate

JMS016 **Symposium** **(1231 - 1250)**

Convener : Dr. Steve Harangozo
Co-Convener : Prof. Konrad Steffen, Prof. David Holland

Cryospheric Change and Sea Level

JMS017 **Symposium** **(1251 - 1260)**

Convener : Prof. Michael Mann

The Holocene-Anthropocene Transition: From Natural to Human-Dominance of the Earth System

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JMS018 **Symposium** **(1261 - 1289)**

Convener : Dr. David Bromwich

High Latitude Modes of Climate Variability

Symposium **(1290 - 1305)**

JMS019

Convener : Prof. Huw Davies

Toward Bridging the Gap Between Weather and Inter-Annual Climate Variability: Processes, Phenomena and Prediction

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JMS020 **Symposium** **(1306 - 1329)**

Convener : Dr. Phillip Arkin
Co-Convener : Dr. Annarita Mariotti

Assessing & Exploiting Re-analysis Data Sets

JMS021 **Symposium** **(1330 - 1355)**

Convener : Dr. Cora Randall, Dr. Yvan Orsolini, Dr. Alexei Krivolutsky

Energetic Particles and Geomagnetic Storm Influence on Chemical and Dynamical Processes in the Polar Stratosphere and Mesosphere

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JMS022 **Symposium** **(1356 - 1373)**

Convener : Dr. Ulrike Langematz

Solar Impact on the Mesosphere-Stratosphere-Troposphere System

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JMS023 **Symposium** **(1374 - 1387)**

Convener : Dr. James Hecht

Instabilities in the Neutral Atmosphere, Ionosphere and Magnetosphere

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JMS024 **Symposium** **(1388 - 1449)**

Convener : Dr. Richard Swinbank
Co-Convener : Prof. Mu Mu

Data Assimilation for the Atmosphere, Ocean and Land Surface

JMS025 **Symposium** **(1450 - 1474)**

Convener : Dr. Robert Cahalan

3D Radiative Transfer in Complex Geophysical Media Including Clouds, Vegetation, Ice and Snow

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JMS026 **Symposium** **(1475 - 1503)**

Convener : Prof. Dorthe Dahl-Jensen

Ice Cores and Climate (UCCS Symposium hosted by IAMAS)

JMS027 **Symposium** **(1504 - 1533)**

Convener : Prof. Claudio Smiraglia

Glacier Fluctuations in the Asian High Mountains (UCCS Symposium hosted by IAMAS)

JMS028 **Symposium** **(1534 - 1552)**

Convener : Dr. Steven Fassnacht

Consequences of Large Scale Circulation Variability on Snow and Ice Extent (UCCS Symposia hosted by IAMAS)

JMS029 **Symposium** **(1553 - 1562)**

Convener : Dr. Karl Kleemayr
Co-Convener : Dr. Sovilla Betty, Dr. Andreas Schaffhauser

Snow Avalanches Field Observations and Modelling (UCCS Symposium hosted by IAMAS)

JMS030 **Symposium** **(1563 - 1576)**

Convener : Prof. Manfred Lange
Co-Convener : Prof. Ralf Greve

Extraterrestrial Ice (UCCS Symposium hosted by IAMAS)

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JMS001 **715 - 728**

Symposium
Our Changing Planet

Convener : Prof. Richard Peltier

This is a continuation of Union Symposium U1, and contains contributed papers. First Monday afternoon is dedicated to fluids and addresses global change originating in the atmosphere (including the magnetosphere), the oceans, and the hydrosphere (including land ice). Topics will include trace gas induced global warming, the role of the oceans in climate variability and change, the stability of the cryospheric, etc. The second Monday afternoon is dedicated to solid Earth processes and the Earths deep interior. Topics in this area may include the physics of the earthquake source mechanism, the geodetic monitoring of tectonic deformation, the style of the mantle convection process and the physics of the Earths core, including the dynamo process and the mechanism(s) of field reversal

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JMS001 **Oral Presentation** **715**

Gravity wave activity in the tropical lower stratosphere with high vertical resolution radiosonde data

Mrs. Xuelian Wang
TianJin Meteorological Bureau,China TianJin Meteorological Institute

Zeyu Chen, Bingyu Du

Seven-year long high vertical resolution radiosonde data (from 1998 to 2004) from eight U.S. stations in the Northwest Pacific were used to investigate the characteristics of gravity wave activity in the tropical lower stratosphere (18-25 km height range). The prevailing zonal wind during the period and height range are westward with a period-like oscillation superimposed in the region. On average, gravity wave activities vary seasonally and weaken with increasing latitude, and exhibit interannual variations near the Equator. The spatial and temporal variations of gravity wave energy density and several key parameters were estimated. Generally speaking, the wave energy density decreases with increasing latitude and is larger in winter than in summer (Northern Hemisphere). Meanwhile, interannual variation is clear seen for estimations at latitudes near the Equator. Further detailed investigation reveals that the maxima of the GW energy density occur when equatorial zonal winds are in the transition phase of the QBO from the easterlies to the westerlies. Wave energy density is found to propagate upward, and the dominant horizontal propagation direction is toward the east. Zonal momentum fluxes exhibit a similar temporal behavior to that seen in the gravity wave energy density. Intrinsic frequencies are generally low and increase with increasing latitude, and the ratios between intrinsic frequency and the Coriolis parameter are ~2.5-3.5. The ratios decrease with latitude slightly. Dominant vertical and horizontal wavelengths decrease with latitude. The vertical wavelengths are found to be longer in winter than in summer.

Keywords: gravity wave, tropical lower stratosphere, qbo

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JMS001 **Oral Presentation** **716**

Recent earth expansion: evidence from the secular change of the earth's principal moments of inertia

Prof. Wenbin Shen

Dept of Physics, School of Geodesy and Geomatics Wuhan University, Wuhan, China IAMAS

Whether the Earth is expanding or contracting is an interesting problem in science. The information of the secular change of the Earth's gravity field supports the conclusion that the Earth is expanding in recent 10 years. The gravitational potential could be expressed as a spherical harmonic series outside the Earth. In practical applications, it could be approximately realized by a truncated series, e.g., EGM96 (the Earth Gravity Model 96), EIGEN-GL04C, etc. The Earth's principal moments of inertia are related to the second order coeficients of the spherical harmonic series. Based on EGM96 as well as EIGEN-GL04C, the principal moments of inertia and especially their temporal variations are determined. All the three principal moments of inertia are gradually increasing at almost the same rate in recent 10 years. This clearly demonstrates that the Earth is expanding at least in recent 10 years. Calculations show that the expansion could not be attributed to the rise of the sea water, which has too week influence on the observed variation of the moments of inertia. It is reasonable to assume that the expansion is a whole process in the interior of the Earth or at least a whole process in the mantle. Calculations show that the Earth is expanding at the rate 0.3 to 0.6 mm/a at least in recent 10 years. Taking into account Dirac's large number postulate, it could be concluded that the Earth expansion has and will have happened continuously in a long geological history.

Keywords: earth, expansion

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JMS001 **Oral Presentation** **717**

A 500-kyr foraminiferal U/Ca and 234U/238U record on Paleo-Surface Ocean pCO2 and Biological Productivity in the Equatorial Pacific

Prof. Shangde Luo
Earth Sciences National Cheng-Kung University

Cheng-Feng You, Teh-Lung Ku

The high-nutrient, low-chlorophyll (HNLC) region in the central and eastern parts of the equatorial Pacific today serves as an important carbon engine on the Earth, in that it sustains about 20-50% of the global-ocean biological productivity and is responsible for the greatest efflux of carbon dioxide (CO2), a green-house gas, to the atmosphere. A constraint on the past changes of the productivity and CO2 efflux in this region is of great importance for understanding the oceans role in regulating the concentration of CO2 in the atmosphere. We report here that measurement of U/Ca and 234U/238U ratios in foraminifer tests as preserved in sediment core P-72 from the central equatorial Pacific can be used as a proxy to assess the changes in surface-ocean partial pressure of CO2, pCO2, and flux of particulate organic carbon (POC), respectively, over the past ～500,000 years. Our results indicate that both surface-ocean pCO2 and POC flux in the area fluctuate with a quasi-periodicity of ～100,000 years during the past several glacial/interglacial cycles. In a comparison with the atmospheric pCO2 as recorded in ice, our results suggest that significant CO2 efflux to the atmosphere, accompanied by a decrease in surface-ocean productivity, occurs mainly during the interglacial times. In contrast, coupled with an increased productivity, such CO2 efflux is significantly suppressed or shut off during the glacial times.

Keywords: uranium isotopes, foraminifers, co2 proxy

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JMS001 **Oral Presentation** **718**

First steps towards a global 2 C-stabilization scenario employing a complex climate model

Dr. Wilhelm May
Danish Climate Centre Danish Meteorological Institute IAMAS

The objective of Article 2 of the United Nations Framework Convention on Climate Change formulated in 1992 is to achieve stabilization of greenhouse gas concentrations in the atmosphere that would prevent dangerous anthropogenic interference with the climate system. The convention further suggests that such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner. In accordance with this, the Council of the Ministers for the Environment in the European Union laid down in a statement dated October 17, 2002, that in order to obtain this objective global efforts should be guided by a long-term objective of a global temperature increase of 2 C over pre-industrial levels and a stabilization of CO2 concentrations below 550 ppm.. In this study, which is the first of its kind, the allowable greenhouse gas concentrations for keeping the future warming at 2 C relative to pre-industrial levels are estimated by using a complex climate model, the ECHAM5/MPI-OM coupled atmosphere-ocean model. That is, these estimates of the allowable greenhouse gas concentrations are more based on physical arguments than the estimated obtained from simplified energy balance models. Furthermore, the variety of actual climatic changes associated with this so-called 2 C-stabilization scenario can only be assessed by means of a complex climate model. This is, however, necessary in order to evaluate how strongly the EU-target affects various aspects of climate and how big an improvement this means relative to stronger emission scenarios. In addition to the allowable greenhouse gas concentrations, the allowable anthropogenic aerosol load and ozone levels are considered. In this study also the actual climatic changes associated with the 2 C- stabilization scenario are assessed in further detail, considering a variety of meteorological and oceanic variables such as temperature, precipitation, sea-ice conditions, sea-level pressure, winds etc. These changes are compared to the respective changes in a markedly warmer future climate (about 3.5 C with respect to pre-industrial times), following the SRES A1B scenario proposed by the IPCC. Also, the impact of the anthropogenic aerosol load and ozone levels on the climatic changes is investigated.

Keywords: dangerous climate change, coupled climate model, stabilization scenario

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JMS001 **Oral Presentation** **719**

Global warming enhances cool and hot summer over Japan

Prof. Isamu Yagai
Meteorology Meteorological College IAMAS

When the low temperature anomaly appeared in summer over the northern part of Japan, warm temperature anomalies were frequently seen over the western part of Japan. This phenomenon was noticed by the longrange weather forecasters in JMA (Japan Meteorological Agency) and named as Cooler North Warmer West. We analyzed the difference of surface air temperature between the western part and the northern part of Japan islands and found that the recent temperature gradient over Japan islands is increasing in spite of cold and hot summers. That is to say, the temperature over the northern part of Japan has a tendency to be cooler than that over western Japan. Such phenomena can be seen in monthly mean surface temperature in every July in the 21st century and August from 2001 to 2004. The summer 2004 was a hot summer; however the cool air mass was advected to northern and eastern parts of Japan in mid August, which brought Cooler North Warmer West. The anomalous cool summer took place in July and August 2003, and the large negative temperature anomalies are seen. The distribution of anomalies are not uniform but the absolute value is tend to larger in the northern part than in the western part of Japan; as a result the temperature gradient over Japan islands is larger than normals. In this way the temperature gradient over Japan islands in July and August tends to be larger than normals in the twenty-first century. This phenomenon will be called Large Temperature Gradient over Japan (LTGJ). Such a feature can be seen in the 10 year mean surface air temperature anomaly in August from 1990 to 1999 by ERA40 data made by ECMWF. We calculated the anomaly of monthly mean index of LTGJ and compare with the global mean surface air temperature over land in July analyzed by JMA. The IPCC report (2001) pointed out that recent global warming started from 1976 when the recent cool summers in the northern Japan began to enhance. The correlation coefficients are calculated ; the value is 0.26 for the last 113 years, which increases to 0.41 from 1976 to 2006 when the effect of global warming increased. The value of the correlation coefficients from 1894 to 1975 was negative (-0.07) when the effect of global warming was not clear. Then, in the twenty-first century (2001-2006), the value reached to 0.67, although the sampling period was small. This indicates that the recent increase of LTGJ is associated with global warming, and therefore LTGJ in July and August becomes to be highly correlated with the global mean temperature over land. Conversely, Japan islands are said to be located in the place where the global warming influences strongly.

Keywords: cool summer, global warming, japan

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JMS001 **Oral Presentation** **720**

Relationships between Global Precipitation and Surface Temperature on Inter-annual and Longer Time Scales During 1979-2006

Dr. Robert Adler
Laboratory for Atmospheres NASA Goddard Space Flight Center IAMAS

Guojun Gu, George Huffman, J. J. Wang

Associations between rainfall and surface temperature anomalies on the longer-than-seasonal time scales are explored for the period of 1979-2006, using the GPCP precipitation product and the GISS surface temperature data set. Positive (negative) correlations are generally observed between these two variables over tropical oceans (lands). This relation becomes even stronger once the effect of two major volcanic eruptions is reduced in the data sets. ENSO is the dominant factor in these inter-annual, tropical relations. The large-scale, inter-annual precipitation-temperature relation is quantified and compared to independent TRMM radar estimates for a shorter period. In the northern hemisphere mid-to-high latitudes, the correlation relationships between rainfall and temperature anomalies are more complicated with positive and negative values of correlation tending to appear over both oceans and land. Furthermore, there seems a strong seasonal variation in correlation in the north hemisphere middle and high latitudes. Most intense long-term, linear changes in annual-mean rainfall anomalies over the period tend to be within the tropics, as do their largest variances. For surface temperature, however, both the strongest linear changes and largest variances are observed in the north hemisphere mid-high latitudes, with much weaker temperature changes in the tropical region and southern hemisphere. Regional variations are also described. Calculations of the ratio of linear precipitation increase to temperature increase over the period are calculated for both the tropics and the globe, and ocean and land.

Keywords: precipitation, climate variations, temperature

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JMS001 **Oral Presentation** **721**

Local and remote tropical air-sea interactions in an IPCC-type coupled model

Prof. James Carton
Department of Atmospheric and Oceanic Science University of Maryland

Tom Delworth

Here we examine tropical climate variability in the Atlantic sector in the historical observational record and in a GFDL coupled atmosphere-ocean general circulation model. Our analysis emphasizes quantifying the mechanisms of remote influence on the climate of the tropical Atlantic. We begin by examining the historical record of variability as revealed by the ECMWF atmospheric and SODA oceanic reanalyses of climate variability spanning the period 1958-2001. Consistent with previous studies, we find climate fluctuations that are seasonally dependent. Boreal spring is subject to variability associated with displacement of the ITCZ, and the trade wind systems, along with anomalies of SST and mixed layer depth, but with little impact on the oceanic thermocline. A significant aspect of this variability is associated with changes occurring in the eastern Pacific Ocean. In contrast, boreal summer is subject to fluctuations in the eastern equatorial basin with less apparent remote influence. In the second part of this talk we compare the results of the observational analysis with an analysis of a version of the GFDL CM2.1 coupled general circulation model. An initial model integration is used to determine a time-independent flux correction that is then applied in a 200-year long simulation. The flux correction improves many aspects of the seasonal circulation including the depth of the oceanic thermocline, surface winds, and SST. Examination of the simulation shows a prominent ENSO signal that includes both interannual and decadal variability. The ENSO signal projects onto both the Northern and Southern tropical Atlantic SSTs with a few months phase lag, as well as onto tropical tropospheric temperatures and continental rainfall. The coupled model also has interesting variability in the North Atlantic sector. Determining the impact and mechanisms of this remote variability on the climate of the tropical Atlantic sector will be a subject of this talk.

Keywords: tropical atlantic, enso, rainfall

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JMS001 **Oral Presentation** **722**

Global Warming and the Weakening of the Tropical Circulation

Dr. Gabriel Vecchi
NOAAGFDL Climate Diagnostics Group IAPSO

Brian Soden

We explore the impact of CO2-induced reduction in the intensity of large-scale atmospheric circulation, resulting from global energetic constraints, on the tropical Pacific atmospheric and oceanic structure and circulation. We examine the projected 21st Century response of the tropical circulation using a set of 22 climate model experiments performed for the IPCC-AR4. In all models there is a robust decrease in the strength of the atmospheric overturning circulation decreases as the climate warms; the circulation weakens in a manner consistent with simple thermodynamic arguments. The weakening occurs preferentially in the zonally-asymmetric (i.e., Walker) rather than zonal-mean (i.e., Hadley) component of the tropical circulation, and results in a weakening the near-equatorial easterlies in the Pacific Ocean. These wind changes induce substantial changes to the thermal structure and circulation of the tropical oceans. Although many aspects of the model changes in both the atmospheric and ocean circulation resemble El Nio-like conditions, the mechanisms are shown to be distinct from those of El Nio and are reproduced in both mixed-layer and full ocean dynamics coupled climate models. Even though the mechanisms and structure differ from El Nio, aspects of climate teleconnections (in particular a strengthening of tropical Atlantic vertical wind shear) resemble those associated with El Nio. Changes seen in the consensus of models presented here are also consistent with recently detected changes in the tropical circulation since the 19th Century.

Keywords: tropical air sea interaction, climate change, el nino

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JMS001 **Oral Presentation** **723**

Investigation seasonal and interannual variability some component of the Caspian Sea water balance on remote sensing data

Dr. Sergey Lebedev
Department of Geoinformatic Geophysical Center of Russian Academy of Sciences IAPSO

Alexander Sirota, Lyubov Ostroumova

During recent century the water level of the Caspian Sea has been fluctuating dramatically, giving rise to the necessity of further investigations of its water balance. Irregularity in the distribution of the climatic characteristics over the sea creates considerable difficulties in the estimation of the water budget components, in particular of the evaporation. The water balance of the Caspian Sea includes the following main components: the total river inflow (the Volga river runoff comes average 80% of total water flow into the Caspian Sea), the outflow from the Caspian Sea to Kara-Bogaz-Gol Bay, the precipitation, the ground water runoff, the evaporation. There is no any device allowing to carry out accurately direct measurements of the each water balance component of the Caspian Sea (for example the evaporation from the sea surface and the Kara-Bogaz-Gol outflow). In this study we are going to use remote sensing data to calculate some component of the sea water balance. Satellite altimetric data was maked to analysis temporal variability the Volga river runoff and outflow to the Kara-Bogaz-Gol Bay . Radiometric and scatterometric (merged with altimetric) data or information of sea surface temperature and surface wind (speed and direction) was used to calculated of the evaporation by modified Braslavskys formula. This work was partly supported by the Russian Fund of Basic Research, Grant No. 06-05-64871

Keywords: water balance, caspian sea, remote sensing data

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JMS001 **Poster presentation** **724**

Natural Hazard Events and Consequent Connections with the Solar Flares for three Last Solar Cycles

Dr. Marilia Tavares
IAMAS

Anibal T Azevedo

We have analysed the occurrence of three different kind of events related to the Earths surface, tsunami, volcanos and earthquakes and compared their respective evolution occurrence rate during three nominal eleven years Solar Cycles. Global analyses of these phenomena were performed and we have examined the relationship between occurrence rates in the Northern and the Southern Hemispheres, as well as on the different tectonic plates . The statistics of the natural hazards was considered independently for each type of event. Our conclusion based on the observations indicate a strong relationship between the 11-year Solar Cycles and the mentioned terrestrial phenomena . Both intensity and time variation of the occurrence rate seems to depend on the Solar Cycle activity (number and intensity of solar flares) in different ways , depending on the actual tectonic plate where the events occurred . An intriguing behavior regarding an increase Volcanos activity on Indo Australian plate simutaneously with a decreased activity on the Eurasian plate during the recent few years, corresponds to the reversal of magnetic field according with a theory developed fo the 22 years of Solar cycles namely the Hale Cycles . The preliminary results indicate that also other factors must be taken into account in future studies. These comprise the Earths orbit around the Sun (eccentricity) , the precession and the axial tilt or the inclination of the Earths axis in relation to its plane of orbit with the Sun . The difference in tilt affects which areas of the Earths surface receives the most and least solar radiation, respectively . These factors are related to the Milankovich cycles.

Keywords: tectonic, hazard, solar

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JMS001 **Poster presentation** **725**

Toward a standard Global Warming

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A quarter of the Ice-Sheet growth is caused by Global Warming in Greenland associated with a record positive-to-negative NAO index reversal The Icelandic low shifted southwestward in Cape Farewell in 1996. The open oceans are tipically micro-tidal in the North Atlantic Hemisphere, with a deflection of water to the right. Satellites data sets suggest that the tropical troposphere has warmed less that the surface which would correspond to an increase in lapse rate. The climate system is strongly influenced by internal variability mode, the gyre index is associated with the leading Sea Surface high mode related to a hurricanes growth over the last decades. The effect of a "leap second" acceleration introduced since 1900 (32 seconds since 1958) in atomic clocks according to the coriolis acceleration due to the rotation of the Earth may be significant at high latitudes causing the greater deflection of water and the last decadal increase of the hurricanes observed in the Northern Hemisphere. Some centimeters per year, only 3.82 cm per year but the days length have slightly changed over the Cambrian, is the rate at which the Moon is currently retreating slowing the Earth rotation. During the year 1996, the GPS time minus UTC Time was 12 seconds. The current Earth rotation measurements techniques are not sensitive enough to detect rotational changes caused by Earthquakes as large as magnitude 8 at present GPS femtosecond accuracy. The preliminary studies for the 2004,3.267N, 95.821E, magnitude 9 ,Northern Sumatra Earthquake show a bilateral rupture on the India and Burma plates with a complex source time function of 210 sec duration and a total scalar seismic moment of 7.25x10 21 Nm. It affected Earth's rotation, decreased the lenght of day by 2.68 microseconds, slightly changed the shape of the planet bulging the equator and shifted the north pole by 2.5 centimeters in the direction of 145 degrees East longitude. The magnetic crustal thickness has increased to the east and northeast, in the direction of the subduction zone, the Earth inner core is rotating faster than the mantle and crust at about 0.3 to 0.5 per year increasing or decreasing the earth magnetic field when each leap second is added and increasing the continental drift, the ephemeris seconds introduced before 1967, for the irregularities in the spin rate of the earth of about 60 milliseconds over the year, required one-year averages The Moon which is rotating with the Earth would evolved at a standard distance, the present one, with even a quarter of the uncertainty introduce in the Time set to Universal Time and Earth Time.

Keywords: atmosphere, utc, mineralisation

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS001 **Poster presentation** **726**

Directed reorganization of the Earth in present epoch and solution of fundamental problems of geodynamics

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Problems of secular changes of rotation of the Earth with all acuteness have risen for astrometrists in before last century (approximately 150 years ago). Attempts of their solution have been undertaken repeatedly and caused rough scientific discussions. The problem of secular changes of geopotential coefficients has arisen rather recently - about 25 years ago, but have already caused many different interpretations, at times rather inconsistent. In numerous publications efforts of various experts with the purpose to understand possible mechanisms of observable changes of the Earth were undertaken at times improbable. In the report the solution and a dynamic explanation of the fundamental problems of geodynamics is offered. The problems about secular drift of the Earth pole, about non-tidal acceleration of axial rotation of the Earth, about secular variations of coefficients of the basic zonal harmonics of geopotential have been studied from general positions and on the basis of one general mechanism of planetary redistribution of masses of the Earth. The uniform mechanism of redistribution of masses of the Earth (oceanic, atmospheric and fluid masses) causes all specified fundamental phenomena. Its dynamic basis is the translational drift of the outer core of the Earth relatively to deformable mantle with velocity of 12.7 mm/yr in the direction of a geographical point (pole P) 70 N, 104.3 E and a directed slow redistribution of atmospheric, oceanic and other fluid masses in the specified direction from a southern hemisphere in northern hemisphere. For an explanation of the mentioned secular variations here it is used the point asymmetric inversion model of secular redistribution of masses of the Earth, set by geocentric axis OP (Barkin, 2001). The model represents system of two material points with masses m2 and m1, located on the Earth surfaces at poles of axis OP, accordingly, in northern and in southern hemispheres. Masses are changed linearly in the time with velocities: 0.179x10 (15) kg/yr and 0.043x10 (15) kg /yr. On our geodynamical model to secular drift of a geocenter there corresponds the identical drift of the Earth core relatively to the elastic mantle in same northern direction (Barkin, 1995, 2001, 2002). The gravitational attraction of superfluous masses of displaced core results to slow secular (asymmetric) redistribution of atmospheric and oceanic masses from the southern hemisphere to the northern. Data of the space geodesy studies confirm the predicted direction of secular displacement of the centre of mass of the Earth to geographic point with coordinates 72.7 N, 115.4 E with velocity about 6 mm/yr (Gayazov, 2003). On the basis of the given model analytical formulas for secular variations of coefficients of the second harmonic of a geopotential have been obtained and velocities of their changes have been calculated (1 Unit = 10 (-11) 1/yr): dJ2 =-3.06, dC21 =-0.294, dS21=1.155, dC22 =-0.095, dS22 =-0.052. Similarly for velocities of secular changes of coefficients of the basic zonal harmonics of geopotential have been evaluated (in same units): dJ2 =-3.06 (-3.07 +/-0.4), dJ3 =-1.51 (-1.3 +/-0.5), dJ4 =-1.76 (-1.4 +/-1.0), dJ6 =-0.27 (0.3 +/-0.7), dJ8=0.94 (1.1 +/-0.8). The values obtained on the data of laser satellite observations are specified in brackets (Cheng, Shum, Tapley, 1997). At last settlement values of non-tidal acceleration of diurnal rotation of the Earth and the components of velocity of the pole drift (divided on the value of angular velocity of the Earth) have been determined on the base of analytical solution of equations of rotational motion of the weakly deformable body (Barkin, 2000). In units 10 (-11) 1/yr we have dw/w=6.19 (6.9 +/-1.7, Stephenson, Morrison, 1995) and for a component of secular drift of the Earth pole: dp/w=388 (395), dq/w =-1505 (1548). Observable values of components are specified in brackets (Gross, Vondrak, 1999). Referenses Stephenson, F.R. and Morrison, L.V. (1995) "Long term fluctuations in the Earth's rotation:700 BC to AD 1990", Phil. Trans. R. Soc. Lond., A, 351, p. 165-202. Gross R.S., Vondrak J. (1999) Astrometric and

space-geodetic observations of polar wander. Geophysical res. Ltrs/ 1999GL900422, Vol. 26, No. 14, p. 2085. 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. Cheng M.R., Shum C.K. and Tapley B.D. (1997) Determination of long-periodic changes in the Earth's gravity field from satellite laser ranging observations. Journal of Geophysical research, V. 102, No. B10. pp. 22377-22390. Gayazov I.S. (2003) Variations of C21, S21 geopotential coefficients from SLR data of Lageos satellites. Proceedings of International conference "Astrometry, Geodynamics and Solar System Dynamics: from milliarcseconds to microarcseconds". Journees 2003 (September 22-25, 2003, St. Petersburg, Russia). St. - Petersburg. pp. 193-202.

Keywords: reorganizations, pole, trend

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS001 **Poster presentation** **727**

Drift of the earth core to the North and Increasing of seismic activity

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Gravitational influence of the Moon, the Sun and other celestial bodies on non-spherical shells of the Earth forces them to make small translational oscillations and turns relatively each other (Barkin, 2002; Barkin, Vilke, 2004). The basic interacting shells are the core and mantle of the Earth. The modern data of geodetic, gravimetry and geophysical observations testify to a reality of the phenomena of drift of the outer core and its translational oscillations with a wide spectrum of frequencies relatively to elastic mantle of the Earth (Barkin, 1995; Barkin, Vilke, 2004; Barkin, Shuanggen, 2006). Some observed phenomena were predicted on the basis of developed geodynamic model (the of the core to the North Pole, the slow expansion of southern and compression of northern hemispheres, non-tidal variations of a gravity etc.). Displacements of the core are accompanied by elastic deformations of the mantle and variations of its tension states contrast in opposite hemispheres. They in turn find reflection in variations of seismic, volcanic and, generally speaking, in variations of all planetary processes. The displacement of the core in northern direction results many natural processes in their activization in northern hemisphere and to reduction of their activity in southern hemisphere. The polar drift of the core relatively to elastic mantle should result in perturbations of the tension state of the top layers of the mantle. The specified phenomenon is shown both in a slow secular component, and in various scales of their temporal variations (in annual, decade and in more long-periodic variations). The centers of earthquakes are mainly located at subduction zones (in northern hemisphere) and much more poorly are shown in spreading zones and other areas. It means, that at displacement of the core in northern direction the seismicity in northern hemisphere and, hence, and in scale of all planet increases, that confirm the seismic data. This tendency will be kept all time while there is a slow drift of the core relatively to elastic mantle. Unfortunately, this concerns to all catastrophic phenomena on the Earth, including heavy climatic changes which the nearest decades will accrue. The data of observations should confirm the phenomenon of slow increase of seismic activity in northern hemisphere and its decrease (but with smaller rate) in southern hemisphere. This phenomenon directly follows from essence of developed geodynamic model. The phenomenon of cyclic inversion of displays of seismicity in opposite hemispheres should be observed at oscillations of system "the core- elastic mantle" of the Earth with interannual, decadal and other periods. The phenomenon of inversion of decade variations of seismic activity of the Pacific belt and of other world is seen in reality (Kusnezov, Keilis-Borok, 1997). Observed phenomenon of mirror - symmetric a component (M - component) of variations of number of earthquakes for northern and southern hemispheres, found out as a result of data processing the catalogue of National information centre on earthquakes, here has been explained on the base of considered geodynamical model. Last phenomenon is characterized by cyclic recession of activity in northern hemisphere, when in a southern hemisphere - rise, and on the contrary (Gorkavyj et al., 1994). The developed geodynamical model explains the observable phenomena of migration of seismicity, the periods of recession of planetary seismicity, the existence and location of global planetary seismic belts and other regularities. References Barkin, Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. Barkin, Yu.V. and Shuanggen, J. (2006) Kinematics and dynamics of the Earth hemispheres. EGU General Assembly (Vienna, Austria, 2-7 April 2006). Geophysical Research Abstracts, Volume 8, abstract # EGU06-A-01680. Gorkavyj N.N., Levitskii L.S., Tajdakova T.A., Trapeznikov Yu.A., Fridman A.M. (1994) About revealing three component in seismic activity of the Earth.. Physics of the Earth, No.10, p. 23.

Kuznetsov I.V., Kejlis-Borok V.I. (1997) Interrelation of earthquakes of the Pacific seismic belt, Reports of RAS, Vol. 355, No.3, pp. 389-393.

Keywords: seismicity activization, coe mantle dynamics, inversion seismicity

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JMS001 **Poster presentation** **728**

Redistribution of water pair masses and an explanation of observable trend of mean atmospheric pressure and its annual oscillation

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The graph of change of mean atmospheric pressure on the all Earth shows rather clear trend in its decrease, its annual variation, and also interannual and decade variations (Salstein, 2005). For the period with 1979 on 2005 the mean pressure decreased with velocity 0.021 hPa/yr, and the amplitude of its annual variation in the specified period makes about 0.68 hPa-0.25 hPa. And rather monotonous decrease of amplitude of annual fluctuation with velocity about 0.017 hPa/yr is observed. According to our geodynamic model in northern and southern hemispheres the phenomenon of inversion of the mean pressure of atmosphere should be observed. Namely, the mean pressure in northern hemisphere should accrue, and in a southern hemisphere on the contrary - to decrease. Besides the mean pressure of atmosphere in N-S hemispheres vary in an antiphase with annual, semi-annual and others periods which were predicted by the theory (Barkin, 2002). Thus the certain asymmetry in masses of atmosphere (and in their canhges) in the corresponding hemispheres should be observed. The basic dynamic reason of the mentioned redistributions of atmospheric masses is the action of mechanism of the forced relative swing of system of the core-the mantle of the Earth. The gravitational attraction of external celestial bodies causes secular and small cyclic motions of the core relatively to elastic mantle. The gravitational attraction of superfluous mass of the core causes the planetary inversion tides in atmosphere and causes the observable redistribution of air masses between N-S hemispheres. On preliminary estimations the velocity of slow changes of mean pressure of atmosphere in N and S hemispheres can make 0.17-0.22 mb/yr and - 0.18 mb/yr, accordingly (Burluzkii, 2007; observation data over the period April 2002 - April 2005). Amplitudes of an annual variation of the mean atmospheric pressure in hemispheres make about 2 -2.2 mb and change in antiphase. The specified variations and inversion redistributed masses have been predicted on the base of geodynamic model (Barkin, 2002). Also similar variations of atmospheric masses, for example, with the periods have been predicted (in days): 2403; 592; 515; 365; 172; 122; 100; 113; 90.7; 69.8; 60.1; 50.4; 40.4; 38.1; 30.5; 27.4; 19.4. According to the developed model in variations of mean atmospheric pressure of hemispheres and all the Earth will be revealed also short-periodic variations with the hour periods (in hours): 24.00; 12.00; 8.00; 6.00; 4.80; 4.00; 3.43; 3.00; 2.67; 2.41 (Barkin, 2002; 2005). It is worth to remark that variations of the atmospheric pressure with mentioned hour periods will be observed on every from meteorological stations. Burluzkii (2007) has shown, that the lump of a dry atmosphere in both hemispheres remains practically constant, but masses of atmosphere in these hemispheres vary in inversion and asymmetric style. The data of observations testify to slow decrease of full mass of water pair in atmosphere with velocity about 0.021 mb/yr (Burluzkii, 2007; on the data for 1979-2005). Approximately with the same velocity 0.015-0.025 mb/yr the mean atmospheric pressure for the specified period was varied (Salstein, 2005). For an annual component the consent of experimental data about variations of mass of water pair in atmosphere and the mean atmospheric pressure again is observed. Thus, we come to a conclusion: observable variations of mean atmospheric pressure of the Earth (trend and various cyclic variations) are caused by processes of condensation and evaporation of water pair. References Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. 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: mean presure, secular variation, water pair redistribution

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JMS002 **729 - 758**

Symposium
Earth System Interactions

Convener : Prof. Guy Brasseur

This symposium is a continuation of Union Symposium U10, and comprises contributed papers. Contributions are expected on cutting edge simulations and analyses of observations of the Earth system and the interactions among its components in the past, present, and projected to occur in the future. Situations of particular interest include the factors and processes affecting the interactions among the atmosphere, oceans, ice and land. Also welcome are contributions addressing human-induced changes that alter climate, contributed to the apparent stability of the pre-industrial climate and led to glacial cycling, and that prevailed during past climatic conditions that were warmer than at present

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JMS002 **Oral Presentation** **729**

Earth System Interactions : Natural Disasters Mitigation-Issues On Ecological And Social Risk

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Prof.Narendra Kumar C., Mrs.Annette P.Kimmich

Asia pacific region is more vulnerable to Geo disasters and impacts of climate changes in recent years. On 26 December 2004 massive waves triggered by an earthquake surged into coastal communities in Asia and East Africa with devastating force. Hitting Indonesia, Sri Lanka, Thailand and India hardest, the deadly waves swept more than 200 000 people to their deaths. Also in an another extreme climate change phenomenon during last week of July 2005 , causing heavy rains and flooding situation in the Mumbai ,and state of Maharashtra .More than 20 million population in the Mumbai metro region alone and 150 million all over the Indian states are witnessing the social- economical and ecological risks and impacts due to climate changes. Also number of hurricanes cyclones forest fire and flash floods occurs around the continents of the globe . The economic losses to coastal ecosystem, agriculture, irrigation, aquaculture, drinking water resources, coastal industries and infrastructure are very high due to extreme geo-disasters that are linked with environmental and climate changes .The ecosystem, economic system, agriculture and aquaculture system in this region are severely affected and need systematic rehabilitation. This presentation reviews the status and issues of rehabilitation of flood affected population in India and along Indian coast focusing on problems and damage arising from the extreme floods, and earthquake and tsunami in south Asia and social and economic losses , and coastal economic systems etc ..

Keywords: earth system interactions, geo disasters, human induced interactions

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JMS002 **Oral Presentation** **730**

CLOUD DUSTING

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Through series of large scale experiments the impact of iron on the algae growth have been clearly demonstrated. Saydam and Senyuva (2002) have further shown the necessary steps as to produce reduced iron within the cloud droplets. During the atmospheric transport of desert dust upon contact with cloud water, oxalate is released by the fungus as an osmosolute. This reducing chemical is used by bacteria and fungis to attaches themselves on the clay minerals as to form iron oxalate. If the solar radiation is above some threshold level along the path of the synoptic scale atmospheric depression photochemical production of bioavailable iron, Fe(II) takes place as a result of decarboxylation reaction. Thus the temporal and spatial variability of bioavailable iron as well as other micronutrient elements such as Zn and Mn delivered to the ocean controlled by the diurnal and latitudinal variations in solar irradiation and the sporadic nature of rain along the path of the synoptic-scale atmospheric depressions. Upon wet precipitation over the ocean surface it results with the bloom of algae Emiliania huxleyi (E.hux). This new aspect offers a great potential for the entire scientific community as it may pave the way for comprehensive studies on the properties of desert soil, i.e., Sahara, Central Asian and Gobi in the northern hemisphere and Patagonian, Australian and Namibian deserts in the south with this novel perspective. This new aspect carries even more importance for those developing nations that happen to own such resources, which were so far dismissed as useless land, offers them the prospect of prosperity, since now we have the technology to be at the right place at right time of the day to seed the clouds with the correct composition of desert dust to sustain Fe(II) production within the clouds and enhancing the wet precipitation with Fe(II) and simulating the phytoplankton growth over the oceans, possibly with a stabilizing effect on climate, as suggested by Charlson et al. [1987] .

Keywords: desert, dust, iron

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JMS002 **Oral Presentation** **731**

Amazon drought and the future of the rainforest

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Jin-Ho Yoon, Jose Marengo, Ajit Subramaniam, Carlos A. Nobre, Annarita Mariott, J. David Neelin

We analyze and model the causes and wide-ranging effects of Amazon drought over the last few decades, with emphasis on a rare drought in 2005 that led to near record-low streamflows, reduced Amazon river plume in the Atlantic Ocean, and greatly enhanced fire frequency and changes in the global carbon cycle. We show a strong influence from the North Atlantic warming that has alsobeen linked to the strong hurricane season. While El Nino influence is typically locked to the wet season, the Atlantic impact concentrated in the Amazon dry season when the hydroecosystem was most vulnerable. We analyze IPCC AR4 model results and compare the predicted precipitation change with present Amazon drought events. The results suggest a drier dry season that would put major stress on the southern Amazon boundary regions, but the heart of the Amazon may be more resilient than some early work suggested.

Keywords: amazon, climate, drought

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JMS002 **Oral Presentation** **732**

Land/sea warming ratio in response to climate change: IPCC AR4 model results and comparison with observations

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Buwen Dong, Jonathan Gregory

Climate model simulations consistently show that in response to greenhouse gas forcing surface temperatures over land increase more rapidly than over sea. The enhanced warming over land is not simply a transient effect, since it is also present in equilibrium conditions. We examine 20 models from the IPCC AR4 database. The global land/sea warming ratio varies in the range 1.36-1.84, independent of global mean temperature change. In the presence of increasing radiative forcing, the warming ratio for a single model is fairly constant in time, implying that the land/sea temperature difference increases with time. The warming ratio varies with latitude, with a minimum in equatorial latitudes, and maxima in the subtropics. A simple explanation for these findings is provided, and comparisons are made with observations. For the low-latitude (40oS-40oN) mean, the models suggest a warming ratio of 1.51 +/- 0.13, while recent observations suggest a ratio of 1.54 +/- 0.09.

Keywords: land, atmosphere, climate

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JMS002 **Oral Presentation** **733**

Global features of the multiple tropopauses

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Juan Antonio Ael, Laura De La Torre, Raquel Nieto, Luis Gimeno

The tropopause has been the focus of numerous studies in the last years. However, although the multiple tropopauses were first observed as early as 1909, they remained almost ignored for around a century. We present global statistics of multiple tropopause reports using IGRA, the most comprehensive and large radiosonde dataset so far. Global and latitudinal multiple tropopauses report frequencies were determined for a little more than 30 years of data. Among the main findings is the occurrence of reports of multiple tropopauses at all latitudes all the year around. Maximum frequencies of occurrence are located near the subtropical jet streams for both hemispheres. Other findings confirm several the ones reported by the very few regional multiple tropopause studies. Meridional structure of temperature for the multiple tropopauses differs from the results of those previous studies. Additionally we use a sample of global representative radiosounding stations to calculate the multiple tropopause parameters. Results derived from calculated multiple tropopause parameters are consistent with the global results derived from multiple tropopause reports from IGRA. Finally the global trends of the multiple tropopauses parameters are shown and discussed.

Keywords: tropopause, multiple tropopauses, ut ls

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JMS002 **Oral Presentation** **734**

Chemistry-climate interactions

Dr. Drew Shindell
IAMAS

The composition of short-lived, reactive species in the atmosphere both affects and is affected by climate. Data on the historical evolution of reactive gases and aerosols is quite sparse, however, so that in contrast with well-mixed greenhouse gases (WMGHGs), estimation of temporal changes typically requires models. These models contain many uncertain processes, especially involving aerosol physics, and rely on uncertain emissions. Thus the linkages between reactive trace species and climate changes are less well established than for WMGHGs. I will discuss model results demonstrating composition-climate interactions for ozone, methane and aerosols. Issues addressed include the climate impacts of : (1) interaction between sulfate and oxidants, (2) aerosol mixing, (3) altered stratosphere-troposphere exchange in a warming climate and the resulting effects on tropospheric ozone, (4) the interaction of solar variability and ozone, (5) the influence of stratospheric ozone depletion on Southern Hemisphere circulation, (6) and changes in natural emissions of methane, VOCs, dust and NOx (from lightning) in a warming climate. I will also discuss efforts to calculate net climate impacts of short-lived precursor emissions, as well as modeling of the relative global and regional impacts of the short-lived chemically and radiatively active species as compared with the WMGHGs in the future.

Keywords: chemistry, aerosols, climate

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS002 **Oral Presentation** **735**

Impact of increased CO2 levels on tropical and extra-tropical mean climate: A CGCM study

Dr. Annalisa Cherchi

Simona Masina, Antonio Navarra

A coupled general circulation model (CGCM) has been used to study the effects of high CO2 concentrations on the mean climate and variability of the Tropical regions. The basic idea is that a strong perturbation in the heat fluxes may affect the ocean-atmosphere interface, as well as the thermal structure of the ocean. The experiments have been performed by means of a global coupled model with interactive ice with carbon dioxide concentration multiplied by a factor of 2, 4 and 16 with respect to a control experiment with present-day mean values. In modified CO2 conditions, the mean state of sea surface and atmospheric temperature, precipitation and wind changes. From the analysis of the main departures from the control simulation it is possible to have an insight on the main mechanisms involved in the ocean-atmosphere adjustment. A detailed analysis has been reserved to the changes which occur on the interannual variability of the Equatorial Pacific Ocean. In particular, we found that when the CO2 concentration increases by about two and four times with respect to the control experiment there is an intensification of the El Nino oscillation. On the other hand, in the experiment with 16 times the present-day value of CO2, the variance of the NINO3 index substantially decreases and the El Nino-like oscillation weakens in intensity and increases its frequency. The impact of those changes on the Northern Hemisphere winter teleconnection patterns has been analyzed as well.

Keywords: ocean atmosphere interface, increase co2, enso

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JMS002 **Oral Presentation** **736**

Soil moisture feedbacks over southern Africa using RegCM3 model

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Bruce C. Hewitson, Mark A. Tadross

This study describes the results from experiments done to investigate soil moisture feedbacks over southern Africa using a regional climate model, RegCM3. First, the choice of domain and the topography overlaid with the landuse classification is presented. A description of the experimental set-up for modeling follows. Changes to the parameterizations and fine-tuning of the convection scheme are highlighted. Caveats regarding the observations, reanalysis data and model physics are discussed. The response of the model to changes in soil moisture is described using various model surface parameters, which show how the surface energy and moisture budget changes. The basic theory of the highlighted feedbacks is explained as part of a general discussion and particular regions of southern Africa especially in Zimbabwe are highlighted where these feedbacks are potentially important to the local climate.

Keywords: land surface, modeling, feedbacks

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JMS002 **Oral Presentation** **737**

Exploring the impact of Sulphur cycle and Carbon cycle interactions on the transient response of the wider climate system.

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Increasingly state of the art climate models incorporate many of the important earth system processes, however less is known about the uncertainties in these parameterisations and how these interact with the wider climate system. Here we examine two key earth system components, the aerosol sulphur cycle and the carbon cycle, and how they influence the historical and future response of the climate in HadCM3. Using an ensemble approach we show how uncertainties in sulphur cycle physics is consistent with a wide range of sulphate aerosol loadings, but has a much weaker influence on the global temperature response. Using a series of parallel runs we demonstrate that the interaction between aerosols and other properties of the earth system (particularly clouds) represents a much more significant uncertainty. In a second set of experiments we illustrate how the inclusion of a fully interactive carbon cycle into this model enhances the climate response and we show for the first time how uncertainties in the wider climate response (transient climate sensitivity) feeds back on the carbon cycle processes. In particular we focus on the stability of the Amazon forest in these runs.

Keywords: carbon cycle, sulphur cycle, uncertainties

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JMS002 **Oral Presentation** **738**

Coupled climate-society modeling of a realistic scenario towards sustainable earth

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For making the sustainable earth realistic, we would have to solve various critical problems such as global warming, food supply, water resource and energy issues. These problems are major obstacles for human being to overcome for a century. Since they are interrelated with each other, we have to search an optimal point among them. This is a main agenda following Kyoto Protocol. The method taken in the IPCC Reports was to provide several scenarios, in which our world proceeds through global warming and the other problems. This approach is useful for us to imagine hypothetical routes to approach the sustainable world. On the other hand, we ought to search the most likely route, which might be far from sustainability, on the basis of our past behavior and socio-economy system, and then, show the way of improving it. Using a coupled model of climate and socio-economy, it is predicted how quickly we will be able to replace fossil fuel with carbon-free energy. The speed is not only dependent on technology but on society, in particular, our incentive to develop new technology, to construct a social system to support its usage, etc. This attempt should provide a basis for us to look for the most optimal route beyond Kyoto Protocol.

Keywords: global warming, modeling

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JMS002 **Oral Presentation** **739**

Perturbations of the Earth system by external celestial bodies and catastrophic cataclysms

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The Earth shells are subject to intensive differential gravitational actions on the part of all external celestial bodies. As individual celestial bodies (non-spherical, non-homogeneous and with different physical properties) they are exposed to the relative swing, small turns and deformations. These external influences on "system the Earth" depend on relative positions and motions of the Moon, the Sun and planets and have cyclic character which is shown in various time scales. Naturally forced actions of the shells against each other result in variations of the tension states of all layers of elastic mantle and lithosphere, the outer core of the Earth, to fundamental redistributions of atmospheric, oceanic and, in general, fluid masses between the appropriate hemispheres. And it will be inevitable for resulting in cyclic variations of all planetary geodynamic and geophysical processes, including seismic processes. In the report the possible correlations of geodynamic and geophysical processes with particularities of orbital motions of the Moon, the Sun and planets in present epoch are discussed. The certain relations between variations in diurnal rotation of the Earth, in motion of its pole, in displacements of a geocenter with activization of natural processes and with their catastrophic displays are revealed. By analytical and numerical methods the temporal variations of the following dynamic characteristics: the elastic energy dW of the Earth luni-solar tides; a force function dU, determining relative displacements and the swing of the Earth shells (its core and mantle) under an attraction of the Moon and the Sun; a tidal component of variation of angular velocity of the Earth dw/w; variations of coordinates of the Earth pole dp/w and dq/w; components of main vector Q and main moment L of forces of inertia for lithosphere as a whole and its basic plates separately (caused by diurnal rotation of the Earth) have been studied. The spectral analysis of the mentioned characteristics dW, dU, dw/w, Q and L is fulfilled, dates of their extreme values (local minima and maxima) Tm for the various periods of time, including the last and current centuries have been determined. In result the important correlations of dates Tm with dates of natural cataclysms and catastrophic accidents Tc have been established for processes: the large earthquakes, eruptions of volcano's and other ecological catastrophes, the large (revolutionary) shocks in biosphere and in a society (demography processes). In many resulted examples of dates Tm and Tc are situated non-casually closely to each other. So practically for all earthquakes with M> 8 the dates of their events Tc in 20th century (their number is 23) and corresponding to them dates Tm (for elastic energy of the Earth) are situated in intervals of time about one-two years. On this basis, dates Tm of the most potential dangerous seismic events in 21 century (Barkin et al., 2006) with M>8 have been determined. Particularities of trajectories of the Earth pole at their exact description also are correlated with dates Tm of variations of dW, dU and dw/w. It was shown, that positions of the seismic belts (zones) and their activity are correlated with parameters of global rotation of the lithosphere. Even demographic crises (on an example of Russia of 20th century) observe precise correlations with extreme states of the tension states of the Earth (dW). Thus, despite of the complex structure of a planet the Earth and "concealing and covering" dynamic reorganization of terrestrial masses (for example, motion of plates, climatic changes), in all planetary processes occurring in its shells, including an atmosphere and biosphere, are unequivocally allocated and are precisely shown cyclic gravitational influences of external celestial bodies. Predominating mechanisms of dynamic relations of discussed processes are mechanisms of perturbation of the Earth system from outside of: the forced swing and deformations of shells of the Earth and luni-solar tides. On the basis of the developed approach the dates of largest earthquakes of the last years have been predicted: Hokkaido

(2003), Sumatra (2004), Kuril Islands (2006) and others (Barkin et al., 2003, 2004). References Barkin, Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. Barkin, Yu.V., Ferrandiz, J.M. (2004) Tidal elastic energy in planetary systems and its dynamic role. Astronomical and Astrophysical Transactions, v. 23, Issue 4 (August 2004), pp. 369-384.

Keywords: catastrophs, earth, system

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS002 **Oral Presentation** **740**

Nonstationary teleconnection patterns associated with ENSO and the potential influence of interannual variability on the millenial-scale dynamics of ice sheets

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The teleconnection patterns associated with interannual variability, and the El Nino Southern Oscillation in particular, are likely to have been different in the past when topographic forcing by massive continental ice sheets altered the climatological planetary wave field. Numerical models may be able to assist in reconstructing what these teleconnection patterns were and how proxy data records should be interpreted. ENSO teleconnection patterns from the Last Glacial Maximum (LGM) to today are simulated using a coupled atmosphere-ocean general circulation model and demonstrate significant regional changes in their temperature and precipitation signatures from the LGM to today. Furthermore, results from a new coupled atmosphere-ice sheet general circulation model driven by an atmosphere that contains these changing ENSO signatures indicate that millenial-scale ice dynamics may have been influenced by the teleconnection patterns of interannual variability, particularly during ice sheet inception and demise. In addition, two-way interaction between the atmosphere and continental ice is required in order to simulate deglaciation on a realistic timescale. These results therefore stress the importance of addressing dynamic and thermodynamic interactions between the atmosphere, the ocean, and the continental cryosphere.

Keywords: enso, ice sheets, teleconnections

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JMS002 **Oral Presentation** **741**

Modelling the trajectories of satellite tracked drifters in the Adriatic during summertime Bora event

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Satellite-tracked drifter data and meteorological wind measurements indicated summer bora event of 22 - 25 June 1995 as interesting from both meteorological and oceanographic point of view. The studied summer situation was controlled by a mesoscale atmospheric disturbance that imparts strong cyclonic vorticity to the wind field, with the orographic effect being of secondary importance. During the bora event currents of 70 cm s-1 were measured by drifter movements tracked along the western Adriatic coast. Drifter trajectories for the selected period were simulated by an oceanographic model forced by the outputs of two mesoscale meteorological models, ALADIN and MM5, and by river discharges. The atmospheric models provided realistic space- and time-varying atmospheric fields (wind, air temperature and humidity) with ca 10 km horizontal resolution by ALADIN and with 9 and 3 km by MM5. Several numerical experiments with different combinations of the three forcing agents wind stress, river discharges and surface heat fluxes were performed. Proper formulation of the drag coefficient was crucial for the correct simulations of the drifter trajectories, as its increased values do reproduce well the effects of the sea surface roughness and atmospheric stability to the surface ocean layer with respect to the observed drifter movements. Numerical experiments revealed that strong current along the western Adriatic coast resulted from a combined influence of the wind stress and river discharges. The importance of the baroclinic, buoyancy driven contribution to the current field was particularly pronounced in the periods with weak winds. At the same time, drifter movements in the open sea area in front of the eastern Istrian coast were the result of the wind stress acting solely.

Keywords: air sea interaction, numerical modelling

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JMS002 **Oral Presentation** **742**

Landslide Damming Induced Hazards in Garhwal Himalaya, Uttarakhand, India

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The Himalayas are the repository of active geological phenomena. The collective interpretation of the available geological and geophysical data shows that the Himalaya has arisen due to the collision of the northward drifting, Indian with Tibetan Plate (Khatri 1992). The Northward shifting of the Indian Plate is continue and continuous horizontal compression of this against Asian Plate is leading to the accumulation of strain which at times is released along the boundary thrusts. This compression put the Himalaya under a continued state of strain. Some of the reactivated old Precambrian tectonic features in the Himalaya also appear to have significant bearing on neotectonism. This quaternary episodic movement along these tectonic planes has rejuvenated the old mature topography of the Lesser Himalayan terrain made of Precambrian rocks. The repeated movement along these tectonic planes give rise plenty of fractures in the rocks. Rainwater penetration along these fractures during heavy precipitation in summer monsoon period give rise tremendous slope failure activities. Downward moving earth material causes frequent damming on the streams and rivers. These landslide born dams cause severe hazards every year in the Garhwal Himalaya. The hazards are particularly common in the form of (i) perishing the settlements upstream of the dam site, (ii) Tremendous damage to the property and life at dam site itself and(iii) flash flooding downstream of the dam due to outburst. Several landslide dams those occurred in last few centuries in the Garhwal Himalaya are studied by the author. On the basis of at site observations and extensive study of the folk literatures, Social interaction, it was found that the landslide damming events cannot be prevented but lose of life and property can be minimized by (a) identifying the vulnerable sites, (b) applying some protective measures

Keywords: flash floods, landslide damming, garhwal himalaya neotectonism

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS002 **Oral Presentation** **743**

Climate variability at Milankovitch frequencies in an atmosphere-ocean-sea ice model of intermediate complexity with an abiotic ocean carbon cycle component

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Cycles at Milankovitch frequencies have been detected in proxy climate records from ocean sediment cores for epochs when little or no ice was present on the major continents. The mechanisms and processes responsible for the translation of the orbital forcing into these climate cycles are not completely understood. Here, processes that might account for these observed cycles are investigated by studying the response of an atmosphere-ocean-sea ice model of intermediate complexity to the orbital forcing. The thermohaline circulation is modeled by using a four-basin (Atlantic, Indian, Pacific and Southern Oceans) zonally averaged ocean circulation model, and the sea-ice model is thermodynamic only. This ocean-sea ice system is coupled to a one-dimensional (latitudinal) energy balance model for the atmosphere. An abiotic ocean carbon cycle model and a one-box model for atmospheric CO2 concentration are also included in the climate model.Results from a 800 kyr numerical integration show that climate variability at Milankovitch frequencies may be a result of the interaction between the orbital forcing, the radiative balance in the atmosphere, sea ice thermodynamics, and ocean circulation processes. In particular, we identify processes associated with the sea ice extent around Antarctica and high-latitude oceanic convection in both hemispheres that serve to rectify the precessional forcing in the climate system. Also, we find that changes in the partition of carbon between the atmosphere and ocean reservoirs follow the changes in the physical components of the model. That is, there are no active feedbacks between the ocean carbon cycle and climate in the model.The potential use of our results for the interpretation of proxy climate data is discussed.

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JMS002 **Oral Presentation** **744**

Detecting human impacts on surface and subsurface thermal environment in several metropolitan areas in Asia

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It has been recognized that anthropogenic forcing is at least partially responsible for the extraordinary 20th century warming. The human influences on climate change are particularly significant in urban areas. Urbanization alters the thermal properties of the land, changes the energy budget at the ground surface, changes the surrounding atmospheric circulation characteristics, and introduces a great amount of anthropogenic waste heat into the urban environmental system. The anthropogenic thermal perturbation in urban areas mostly originates near the ground surface and propagates both upward into the atmosphere and downward into the subsurface. Over the past decade, tremendous efforts have been devoted to improve our understanding of the anthropogenic effects on the atmospheric temperature change. In comparison, little has been done in understanding the human impacts on the subsurface temperature and their environmental consequences. The dominating heat transport mechanism in the subsurface is heat conduction, which is much less efficient than the heat convection of the air above the ground surface. Under many circumstances, the anthropogenic thermal impacts on the subsurface are more persistent and profound than the impacts on the atmosphere. With the world wide urbanization growing at an unprecedented pace, there is an urgent need to improve our understanding of the subsurface urban heat island and its environmental, social, and economical consequences. In this study, we analyze sociological, meteorological, and subsurface temperature data for a better picture of the human impacts on the urban thermal environment across the ground surface. This study is part of the ongoing effort of the multidisciplinary research project Human impacts on urban subsurface environment which has Tokyo, Osaka, Bangkok, Seoul, Nagoya, Taipei, Manila, and Jakarta as its target research areas. The project is sponsored by the Japanese Research Institute for Humanity and Nature.

Keywords: urban heat island, anthropogenic forcing, subsurface

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JMS002 **Oral Presentation** **745**

Reconciling measurements and modeling of the atmospheric chemistry and budget of ethanol

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Ethanol, an oxygenated volatile organic compound (OVOC), is used extensively as a motor fuel and fuel additive to promote clean combustion. Limited available atmospheric observations suggest a global background atmospheric ethanol mixing ratio of about 20 pptv, with values up 3 ppbv near source regions; however, the sources and sinks of ethanol remain poorly understood. Using measurements in the Pacific troposphere, the current global source of ethanol is roughly estimated to be about 12 Tg/yr with approximately 10 Tg/yr emitted directly from anthropogenic and biogenic sources and 1-3 Tg/yr attributed to photochemical oxidation of ethane. Here we use the global three-dimensional chemical transport model, MOZART-4, to investigate the consistency between atmospheric observations (from field campaigns over the past decade covering the remote Pacific, the United States (US), and downwind of Asia and the) and the current understanding of the global ethanol budget. We find that applying a global ethanol source of 5.7 Tg, (approximately 90% in the northern hemisphere), andan in-situ sourceof 0.05 Tg/yr from ethane oxidation in MOZART-4 severely underestimates (by a factor of ten) the observed ethanol concentrations in all regions. We have explored several potential explanations for this discrepancy by performing sensitivity simulations that either increase the source or decrease the sinks (reaction with hydroxyl radical and deposition). Uniformly enhancing the anthropogenic emissions by a factor of ten increases simulated ethanol concentrations over the source regions to match the observations but concentrations over remote regions (e.g., South Pacific) are still underestimated by a factor of ten. Redistributing the emissions spatially so that only 75% of the source is in the northern hemisphere to account for growth in biofuel use in South America and South-east Asia also fails to increase the simulated ethanol concentrations over the remote regions sufficiently to match observations. Decreasing the ethanol oxidation rate by a factor of two in the model improves the comparison with observations only slightly, and decreasing the deposition has no effect. Our preliminary analysis suggests that an in-situ source of ethanol may be needed to explain the observedbackground ethanol concentrations in the remote Pacific region.

Keywords: ethanol, atmospheric budget, mozart

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JMS002 **Oral Presentation** **746**

Groundwater discharge to inland and semi-enclosed seas and its influence on global change

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Globally, submarine groundwater discharge has been estimated to be a small percent of the total freshwater flux but, regionally, for some inland and semi-enclosed seas the groundwater flux has been estimated to be much higher. In the Mediterranean, karst composes 60 % of the shoreline and is estimated to contribute 75 % of the freshwater input. It must be recognized that submarine groundwater discharge (SGD) includes not only freshwater from the land but also seawater that is recirculated through the sediments by the groundwater discharge. SGD can be the principal component of freshwater to the coastal zone and it can cause substantial loss of freshwater from arid regions. Because it is also responsible for limiting saltwater intrusion into the aquifer, its nature can determine the reliability and extent of potable water supplies. SGD often makes a disproportionately large contribution to the flux of dissolved pollutants. In addition, the SGD drives the recirculation of seawater, which can influence coastal water quality and nutrient supplies, coastal wetlands, and breeding and resting grounds. Its influence in the coastal zone can be the basis for land use planning and present limits on development. SGD in some regions can endanger compliance with international or regional conventions on pollution source controls. Besides the loss of potable water, some of the most serious problems arise where SGD is carrying pollutants (nitrogen mainly) from the land into restricted coastal waters. Pollutant input via SGD has been the cause of eutrophication of, for example, in the Aral Sea (Kontar et al, 2003). The effect of SGD in supplying dissolved constituents or, perhaps, in merely reducing salinity has been implicated in the occurrence of nuisance algal blooms. The distribution of SGD can also affect benthic habitats. Eelgrass beds can be reduced and the opportunistic growth of micro alga increased. In some places, low salinity seeps could provide special habitats on the sea floor especially for fishery stock. Or the seepage of groundwater may actually produce changes in morphology or substrates that serve as microhabitats. Very rapid seepage can destabilize sediments on the sea floor or at the coastline by sapping. SGD through sediments with a high organic content can accelerate the release of methane into the overlying water. Locally, SGD could lead to hypoxia in the open water and, globally, it would contribute to the greenhouse gases causing global warming.

Keywords: groundwater discharge, greenhouse gases, global warming

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JMS002 **Oral Presentation** **747**

Analysis of seasonal cycles in 50-year records of atmospheric CO2 using an AGCM based transport model

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Measurement of CO2 was started by C. D. Keeling during the IGY1957 at South Pole followed by Mauna Loa in 1958. Since then the network for recording spatial and temporal variations in atmospheric CO2 have grown rapidly, up to about 200 in 2005. While the large recent network gives us useful information on CO2 sources and sinks distribution, the long term monitoring has enabled tracking changes associated with land and ocean ecosystems owing to the climate change (Keeling et al., Nature, 1995; 1996). Here we focus on transport model analysis of trends in seasonality at several SCRIPPS Institution of Oceanography (SIO) stations, namely BRW (Barrow), CHR (Christmas Island), LJO (La Jolla), MLO, SMO (Samoa) and SPO. The CCSR/NIES/FRCGC AGCM nudged with ECMWF 40 year reanalysis (1958-2002) and NCEP2 reanalysis (1990-continuing) are used in this work (e.g., Takigawa et al., JGR, 2005). Both the observed and modeled concentrations are passed through a digital filter to decompose the time series into seasonal cycles and long-term trends. We find that a large part of the interannual variability in the seasonal cycles is caused by changes in the large-scale atmospheric transport, in addition to the CO2 flux variability. The transport anomalies are illustrated using non-biogenic trace constituents in the atmosphere (SF6 and Radon-222 here). Our SF6 simulations successfully capture the trends between pioneering observations by James Lovelock in 1972 and present. Our results suggest the trends in fossil fuel burning component of CO2 flux can account for significant part of the overall long-term amplitude rises in CO2 at some northern hemisphere stations, such as LJO, MLO, and shifts in seasonality at the southern hemisphere stations, On the other hand large part of the interannual variability in CO2 growth rate at MLO can be attributed to regional flux variability, predominantly in the tropics, derived by the atmospheric CO2 inversion for the 1990s (Patra et al., Tellus, 2005).

Keywords: atmospheric co2, global carbon cycle, agcm transport modelling

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JMS002 **Oral Presentation** **748**

Autonomous millennial oscillations of glacial climates

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We investigate the possibility that the millennial oscillations of the last glacial climate cycle the so-called Dansgaard-Oeschger (DO) oscillations are not forced externally but are the result of interactions internal to the atmosphere-ocean-ice system. Under mixed boundary conditions millennial oscillations of the thermohaline circulation have been shown to occur spontaneously in a wide variety of oceanic models when the forcing by the hydrological cycle is large enough. What happens is that the ocean oscillates between two states, a strong circulation state dominated by thermal gradients and a weak circulation state dominated by salinity gradients both of which are unstable. There is a difficulty to apply these ideas directly to the DO oscillations however, because climates colder than present are bound to involve weaker hydrological cycles. When coupling in two dimensions the atmosphere (with an energy balance model), the sea ice and the ocean we have found through sensitivity studies that these oscillations of the thermohaline circulation are favored with a cold climate initialization. These oscillations of the thermohaline circulation become stronger candidates to explain some of the variability of the last glacial record.

Keywords: millennial, climate, oscillations

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JMS002 **Oral Presentation** **749**

Megacity Radiative Forcing: A Mexico City Case Study

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We quantitatively assess the radiative forcing of the largest megacity in North America, Mexico City. While particular aspects of the regional environmental impacts of cities on their surroundings have been thoroughly investigated, e.g., air quality and acid rain, relatively little effort has been focused on the net radiative impact of a megacity on global climate. The range of radiative impacts from a megacity covers many spatial and temporal scales from short-term regional-scale effects due to aerosols and relatively short-lived gases (ozone) to long-term global-scale impacts due to longer-lived trace gases (e.g., carbon dioxide, methane). In this study we combine chemistry-transport model simulations from the Model for Ozone And Related Chemical Tracers (MOZART-2) with in situ measurements collected during the Megacity Initiative: Local and Global Research Observations (MILAGRO) field campaign in Mexico City and satellite observations from the Aerosol Robotic Network (AERONET) and the Moderate Resolution Imaging Spectroradiometer (MODIS) to calculate the global radiative forcing of megacity emissions. We also explore the radiative impact of various emission control strategies that focus on improving regional air quality. Our results suggest that the warming by greenhouse gases like carbon dioxide and ozone can be moderated or exacerbated by aerosols depending on their optical properties. As the size and number of megacities increase and clean air regulations are implemented, metrics such as the net radiative forcing may become increasingly important in comparing the impact of urban centers and assessing the trade-offs between improving local air quality and minimizing global radiative impacts.

Keywords: pollution, climatechange, urbanization

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JMS002 **Oral Presentation** **750**

Present, Past, and Future Climate Effects and Efficacy of Dirty Snow

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Industrial and biomass burning emissions and dust from low- andmid-latitudes dominate the absorbing impurities trapped in snow atmid- and high-latitudes. We study the climate effects of smoke anddust using a general circulation model driven by observed andpredicted aerosol emissions determined from satellite and in situobservations. The model treats previously neglected aerosol andsnowpack radiative and thermodynamic processes and so captures newpositive feedbacks. The predictions compare well with observed snowalbedo evolution and impurity concentration.We find that black carbon (BC) and dust aerosols in snow have climatechange efficacies (surface temperature response per unit forcing) 3-4times greater than CO_2, making dirty snow the most efficacious forcingagent known. We estimate total (natural + anthropogenic) dust and sootsnowpack-forcing of 0.05-0.07 W m^{-2} warms present global climate0.1-0.2 K. Anthropogenic soot from fossil/bio-fuel sources causes morethan 50% of this warming, and biomass burning can account for up to20% in strong tropical or boreal burn years. During the Last GlacialMaximum increased snowpack dust concentration from desert andglaciogenic sources warms equilibrium climate about 2 K. This exceedsthe LGM climate cooling by atmospheric dust and suggests causal linksbetween dust-ice interactions and glacial terminations.Future dust/soot-snow/ice interactions depend on the trajectories ofdust and soot emissions and snow/ice cover. Changes in dust andbiomass burning aerosol depend on interactions of precipitation, fire,CO_2 fertilization, and land-use change and are thus highly uncertain.Industrial soot emissions will likely increase for many decades, whilesnow and ice cover decreases. We will report on how dirty snowforcing may impact 2050s climate.

Keywords: soot, dust, snow

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JMS002 **Oral Presentation** **751**

Interannual predictability of the precipitation and water table level

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This paper claim to prove the spatial-temporal relation and the predictability between the precipitation field and the water table level on a regional scale, by using the series of both variables in the simultaneous periods. The study was focussed on the period 1970-2003, and after proving the relation between the climatic variability and the response of the unconfined aquifer, potential prediction and diagnosis tools were considered to analyse its future behaviour in 7 years' time, which would contemplate the local and regional scale. The analysis of the precipitation and water table level data on the temporal scale of climatic variability, demonstrated that the precipitation and water table level fields correspond to each other spatially, and have an almost identical behaviour in time over northern of Humid Pampa (the precipitation field as well as the water table level field have identical oscillation modes 8.0, 4.8 and 3.0 years). The reconstruction of each oscillation mode allowed to establish, by adding the three of them, the statistical trend of precipitation anomalies in the region, whose cyclic nature of reconstruction imply predictability. The trend reconstruction, in addition to each mode of water table level oscillation in the period 1970-2003, permitted to establish, by their addition, the statistical trend of the water table level variations in the region, whose cyclic nature of reconstruction also imply predictability, except in the case of occurrence of EL NIÑO phenomenon with extraordinary characteristics in intensity or duration. Quantitatively, the correlation between the precipitation fields and the response of the water table level by means of a SVD provided a correlation coefficient of 0.79 with a lag of a year, which indicates that the results obtained can be acceptable in and among the study variables. The studies performed indicate that the unconfined aquifer has internal oscillations which describe its behaviour and are modulated, which is not observed in precipitation. Therefore, each signal contribution will depend on this modulation. The results of this paper will hopefully contribute to the knowledge of the atmosphere-aquifer relationship on a regional scale, thus accepting the possibility of tendency forecast of each field over a future temporal horizon, where the recharge behaviour in time is correlated to the climatic variability and its magnitudes indicate what could be expected.

Keywords: interannualpredictability, precipitation, watertablelevel

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JMS002 **Poster presentation** **752**

Long-periodic variations of the pole motion and tension state of the Earth

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One of the first attempts of a dynamic explanation of long-periodic behavior of amplitude (Ach), the period (Tch) and phase (PHch) of Chandler perturbed motion of the pole has undertaken by the author (Barkin, 2000). The mechanism of the forced relative swing of the Earth shells by external celestial bodies was put in a basis of study. The action of this mechanism has been illustrated on the base of the simple model of eccentric core of the Earth displaced in direction of Southern America. The special form of equations of the rotation of a weakly deformable body in Andoyer variables has been used in this study. It was shown, that amplitudes of variations of Ach and unperturbed value of amplitude of Chandler (for concrete epoch) are connected by the certain analytical expression which is approximately carried out for observable values of parameters (Barkin, 2000). On variations Ach, Tch and PHch the appropriate variations of products of inertia of the Earth with the period about 425 days (close to period of free pole motion of deformable Earth) were determined. Thus the basic observable 40 years variation of amplitude and period of Chandler has obtained an explanation. The periods of other decade variations of movement of the pole (Barkin, 2000) have been estimated. The gravitational influence of the Moon, the Sun and planets on the system the core ? the mantle results in variations of the tension state of the Earth and to deformations of the mantle and, as consequence, to variations of products of inertia and to perturbations of the pole. The specified processes are deeply interconnected. If the mechanism of the swing of shells is real we have the right to expect, that a variations of the tension state of the Earth, for example, of elastic energy of the mantle, should correlate with variations of Chandler motion. The executed analysis has shown, that the similar tendency we observe actually in rotation of the Earth and in many others geodynamic, geophysical and even society processes, which are discussed in report. In the report the phenomenon of concurrence of dates of extreme values of the envelope of elastic energy caused by action of the specified mechanism, and also by the classical mechanism of luni-solar tides (Barkin et al., 2006), and envelopes of variations of coordinates of the Earth pole for the period of observations of 1840-2000 is discussed. Rather precisely specified correlations are shown in the early period of observation of motion of pole in period 1840-1900 that gives additional arguments for the benefit of them enough to high accuracy. We shall notice also, that the forced motion of the pole causes additional tides in the Earth and gives the certain contribution to full elastic energy. References Nastula J.A., Korsun A., Kolaczek B., Kosek W., Horakowski W. (1993) Variations of the Chandler and annual wobbles of polar motion in 1846-1988 and their prediction. Manua Geodetica, 18, pp. 131-135. Vondrak J. (1999) Secular and long-periodic polar motion as derived from combination of astrometric and space geodetic observations. Pp. 195-201. Kolaczek B., Kosek W. (2000) Variations of the amplitude of the Chandler wobble. Journees. Pp. 216- 220. Barkin, Yu.V. (2000) A mechanism of variations of the Earth rotation at different timescales. In: Polar Motion: Historical and Scientific Problems (Eds. Steven Dick, Dennis McCarthy, and Brian Luzum)/ Proceedings of IAU Colloquium 178 (Cagliari, Sardinia, Italy, 27-30 September 1999). Astronomical Society of the Pacific conference series, V. 208. Sheridan Books, Chelsia, Michigan. pp. 373-379.

Keywords: pole motion, shell ineraction, decade variations

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JMS002 **Poster presentation** **753**

A seasonal, coupled atmosphere-ocean-sea ice model of intermediate complexity with an abiotic ocean carbon cycle component: model deion

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In order to carry out global climate simulations over long time scales (e.g., 1 Myr) or to conduct a large number of climate sensitivity studies, we often require models that need to be less computer-time demanding than General Circulation Models but more sophisticated than simple box models. To fulfill these model requirements, the so-called Earth system Models of Intermediate Complexity (EMICs) have being developed. Here, we present an atmosphere-ocean-sea ice model of intermediate complexity in which a seasonal cycle is implemented in each of its components. An important feature of the model is the inclusion of an abiotic ocean carbon cycle component. To simulate the oceanic thermohaline circulation (THC), we employ the zonally averaged circulation model of Wright and Stocker. Four constant-depth ocean basins are considered: Atlantic, Indian, Pacific, and the Southern Oceans. A parameterization for the effect of the subsurface ridges in the Drake Passage region on the THC is implemented. For the ocean carbon cycle component, a simplified version of the abiotic one developed for the Ocean Carbon Model Intercomparison Project is employed. The use of a one-box model for the atmospheric CO2 concentration (pCO2 atm) allows carbon exchange between the ocean and atmosphere. A one-dimensional (latitudinal) Energy Balance Model (EBM) for the atmosphere is implemented, and the atmosphere-to-space longwave radiation flux is a function of atmospheric pCO2 atm. The hydrological cycle is prescribed, and the storage of heat, humidity and carbon is neglected on land. The sea-ice cover is modeled by using a classical thermodynamic model. We use a two-stage procedure to spin up the model under present-day forcings. First, the ocean circulation component is spun up alone under restoring boundary conditions for temperature and salinity until a steady state is reached. The output from this equilibrium state, obtained after a 5 kyr run, is used in conjunction with climatological data to compute the parameters for the EBM (e.g., emissivities for longwave radiation and eddy diffusivities for meridional heat fluxes in the atmosphere). This method for computing these parameters avoids the use of flux adjustments. Second, the sea-ice component and the EBM are coupled to the ocean circulation model and this coupled model is integrated another 10 kyr in order to reach a new steady state. During stages one and the first 5 kyr of stage two, a constant pre-industrial value of pCO2 atm is used to spin up the ocean carbon cycle component in conjunction with the physical model. During the last 5 kyr of stage 2, we allow pCO2 atm to be a prognostic variable by activating the box model for atmospheric CO2.By the end of the spin-up procedure, the model reaches a steady state that is in good agreement with present-day observations of oceanic, atmospheric, and sea-ice variables. A realistic THC is simulated and no climate drift occurs. An application of the model to climate variability at Milankovitch frequencies is discussed in a second paper.

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JMS002 **Poster presentation** **754**

A new coupled model for land-atmosphere interaction study

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A new land-atmosphere interaction model (R42_AVIM) is fulfilled by coupling of a GCM called SAMIL with the land surface model AVIM (atmosphere-vegetation- interaction-model). SAMIL is the new version general circulation model of the China Institute of Atmospheric Physics/State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG/IAP), which is a rhomboidally truncated spectral model with horizontal resolution 2.8125 (lon)1.67 (lat) and vertical resolution 9 levels. AVIM contains physical processes and biological processes. The energy and water cycles are involved in the physical processes, such as radiation transfer, sensible heat exchange as well as rainfall, interception, drainage, surface runoff, infiltration, evapotranspiration, etc. Biological processes relate to carbon cycle between plant, air and soil, including photosynthesis, respiration, dry matter allocation in the tissues and decomposition of organic matter, etc. All these physiological processes are affected by photosynthetic active radiation, CO_2 concentration in the atmosphere, temperature and moisture of air and soil. Meanwhile, the leaf area index (LAI), and then the roughness, albedo and other dynamical parameters of vegetation change with the growth of plant and will influence energy, water and CO_2 exchanges between the surface and the atmosphere, thus to realize the two-way interaction between climate and vegetation.The R42_AVIM model is integrated for 15 model years and the last 10-year average of the outputs acts as climatological mean and is to be analyzed. By comparing with the NCEP/NCAR (National Centers for Environmental Prediction/National Center for Atmospheric Research) reanalysis data and the Climate Prediction Center(CPC) merged precipitation data(CMAP), the simulation results indicate that the performance of the new model is really well. It can basically ensure energy balance on the interface of land and atmosphere, and can simulate JJA and DJF land surface temperature, sensible heat flux, latent heat flux, precipitation, sea level pressure quite well. As for the biological processes, the simulated leaf area index (LAI) has reasonably seasonal change, and the distribution of maximum value is located in Amazonia and tropical rainforests of Africa and Indonesia, whereas the second largest in boreal forests. The results are in accordance with the LAI data provided by the Max Planck Institute for meteorology. In addition, simulations of NPP and total biomass also have reasonable distribution. For NPP simulation, compared with the work of Field et al. (1998), the spatial pattern is right consistent with their results.In this two-way interaction model, LAI is not artificially prescribed as many land surface models do, but dynamically computed according to physical conditions as temperature and humidity. That is, vegetation and atmosphere can impact on each other. So, we can use the model to study the interaction at the seasonal, interannual and decadal scales in the future work. This new model supplies a good platform for further research.

Keywords: r42 avim, land atmosphere, interaction

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Knowledge management of the Earth system

Prof. Teodosio Chavez_campos
iaga no

Israel Chavez Sumarriva, Nadia Chavez Sumarriva, Liliana Sumarriva Bustinza

The administration of the knowledge and the process means of which acquire generates we store, share and use knowledge, information, ideas and experiences to improve the taking of decisions, as wealth of individual and also organizational growth, capitalizing the potential of the human resources. We propose to use this applied tool the different organizations that study the earth, for it is necessary a reference system and that it comes to be considered.In the Final Report of the IUGG (Sapporo, Japan, June30-July 11, 2003) Working Group Geosciences: The Future say: The study of the Earth as a dynamic system is very important to understand our planet and the conditions that allowed the life to develop on it. We are consider an chronometer natural coordinate and classify the observations and this chronometer comes to be the vernal point, defining the vernal point as" a sensitive axis of maximum conductivity" it demonstrates the stability of the geomagnetic equator, in the year 1939 it is confirmed with tabulated data of the Geophysical Institute of Huancayo (Peru), from that date until this year (2004) and this fluctuating between the 12 and 14 S, on the other hand in the area of Brazil it has advanced very quickly toward the north, and above to 108 km. approximately it is located the equatorial electrojet that is intense in the equinoxes in South America. The displacement of the vernal point, it will allow the elaboration of scenarios and it can pass to be part of the activities of administration of the knowledge inside those seven associations: (IASPEI, IAVCEI, IAPSO, IAHS, IAG, IAMAS, IAGA), that comprise the International Union of Geodesy and Geophysics (IUGG).

Keywords: knowledgemanagement, vernalpoint, equatorialelectrojet

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JMS002 **Poster presentation** **756**

Morphometric analysis of the western Crete watersheds, Greece, using geographic information systems

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The study area is western Crete in southern Greece, located near to the Hellenic trench and constituting a conjunctive point between the Eurasian and African plates. That fact places it in one of the most active tectonic structural and seismic regions in the whole Europe, due to the subduction of the African plate beneath the Aegean area. One of the main characteristics of the island is the complex relief structure with high mountains revealing important geologic activity million of years ago until recently. That activity is reflected in the complicated drainage network among the high mountains the investigation of which is important for geomorphologic and tectonic studies. One of the principal objectives of this work is the morphometric analysis of the drainage networks in the basins of Chania prefecture of western Crete Island, Greece. In order to study and determine the drainage characteristics of the basins, Aster (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite imagery linked with topographical maps of scale 1:50000 from HMGS (Hellenic Military Geographical Service) and DEMs (digital elevation models) with 30m resolution were used in advance. The use of GIS was an essential tool in order to map and analyze those values for the characterization of the stream networks and drainage basins. Stream networks were digitized from topographical maps and were updated from Aster satellite imagery by applying the abstraction of band 3N to band 1 (band 3N-band 1) while drainage basins were digitized using as source the 1:50000 hydrolithological maps of the study area. The calculated morphometric parameters included the basic parameters (number of streams, perimeter of basins, total stream length, basin length, area of drainage basins), the derived parameters (bifurcation ratio, stream frequency, drainage density, texture ratio, constant of channel maintenance, average stream-length ratio, length of overland flow), and the shape parameters (elongation ratio, form factor, basin circularity) and were extracted in a GIS environment. Moreover, parameters as the slope, and the aspect were derived from the DEMs. The interpretation of morphometric parameters in the study area, which is characterized by recent terrain movements such as the occurrence of AD 365 earthquake, reveals important data as far as the erosion status, the presence of drainage network anomalies, relief elements and active structures. The above constitute useful information in the neotectonic study of western Crete. The project is co-funded by the European Social Fund and National Resources in the framework of the project INTERREG III B ARCHIMED, sub-project A1.020 entitled "Methodology integration of EO techniques as operative tool for land degradation management and planning in Mediterranean areas.

Keywords: geomorphometricanalysis, gis, neotectonic

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JMS002 **Poster presentation** **757**

Comparison of water budgets Simulations using Weather Research & Forecasting (WRF) model forecasts over Iran

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This article discusses the simulation of water budget over Iran using WRFs model forecasts. A Land Surface parameterization Schemes(LSMs) is an algorithm for determining exchanges of energy, mass and momentum between the atmosphere and land surface. Realistic of land surface process is well known to be of importance for atmospheric modeling system. Weather Research & Forecasting (WRF) model is a next -generationmesoscale modeling system. Currently it is possible to choose from three LSMs to represent land-surface processes in the Advanced Research WRF(ARW) modeling system version2.The three LSM are :a) A5-layer thermal difussion with no explicit vegetation b)Noah LSM that is a 4-layer soil tempreature andmoisture model with canopy moisture and snow cover prediction c)Themodel Rapid Update Cycle (RUC)with 6-sublayer soil and up two snow layers. This case is being studied over Iran from 27 December 2006 to 1 January 2007. During this period, A heavy rainfall caused by passing cold front and then a strong high pressure cell moved to the west of Iran following the passage of cold front. The high pressure cell was caused decrease in tempreature. During this period ARW is being executed by different LSMs and then prognostic outputs that is involved Rainfall, Runoff and soil moisture are being compared to meteorological data (GFS) used to run WRF. These comparisions expresses how WRFs Land Surface Schemes affect the simulation of water budget.

Keywords: wrf, arw, lsms

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ENSO modulation of the upper level cyclonic vortex over the Northeast of Brazil and tropical Atlantic Ocean

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The variability of the atmospheric circulation over South America and adjoin oceans is modulated by the global atmospheric circulation. The variability of the global circulation is driven by the solar activity variability and internal oscillation modes. The El Nio Southern Oscillation (ENSO) phenomena is the main system that modulates the atmospheric circulation over the South America . The upper level cyclonic vortex (ULCV) is one of the main systems that produce alterations on the weather of Northeast Brazil (NEB). The intense trough of upper levels (TUL) overNEB has the similar behavior as the ULCV. Here we present an analysis of the spatial distribution of cyclonic vorticity associated with the ULCV/TUL and its relation with ENSO. Maps of spatial distribution of the frequency of occurrence of relative vorticity were constructed. Three sub-regions: Northwest of the NEB, central of the State of Bahia and the semi-arid were selected. Two cases of ULCV were selected, the first one in an El Nio year and the second in La Nia year, to compare the vorticity frequency and intensity over the sub-regions. The results show a high density of cyclonic events over the NEB, except in the sub-region of northwest. In the summer of El Nio (1997-1998) a higher density of cyclonic events was observed in the semiarid sub-region. On the other hand, in the summer 1995-1996 (La Nia) had a decrease in the number of days with cyclonic vorticity. In this year of La Nia , the three sub-regions practically did not suffer influences of subsidence centers of ULCV. The case studies showed that as much as in the years of El Nio as in years of La Nia intense ULCV that are capable of inhibiting the rains through subsidence centers can occur.

Keywords: upper level cyclonicvortex, enso, climate change

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JMS003 **759 - 841**

Symposium
Satellite Observations: Products and Applications

Convener : Prof. James Drummond

Starting with the launch of Tiros-N in 1978, satellite observations have revolutionized our view of the Earth and other planets. Observational techniques have been incorporated into many activities, often being used in unanticipated ways. Satellite observations are now a vital part of many scientific, industrial and social activities affecting many discipline areas and have had a significant impact in studies of many issues, both societal and scientific. This symposium will bring together practitioners from a number of fields to celebrate the success of this endeavor and to demonstrate new and exciting uses for these data. It will consist of both invited and contributed papers on a wide range of topics covering all aspects of space-based observations

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JMS003 **Oral Presentation** **759**

Application de la teledetection dans l'evaluation de la diversité ecologique des massifs forestiers en Algerie

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Les forts en Algrie prsentent une diversit cologique assez importante, li au diffrent tage bioclimatique en allant du aride vers lhumide. Ces tages ont une influence direct sur les cosystmes forestier et conditionne la composition floristique de ces forts ainsi que leur rgnration. Cette diversit cologique des forts de part sa constitution elle joue un rle important dans la rgnration naturelle suite a un incendie. La conservation de la diversit biologique et la mise en valeur durable des cosystmes Forestiers prennent de plus en plus dimportance. Car les cosystmes ont la particularit de runir la richesse biologique des forts, des eaux intrieures, des terres agricoles et des terres arides et sub-humides. Les recherches en cologie ont fait progresser la connaissance sur le fonctionnement des cosystmes forestiers et sur l'impact des activits humaines (Feux, coup de bois). Lhomme mesure ainsi mieux limportance des modifications quil apporte son environnement. Non seulement il peut amliorer en consquence ses pratiques, mais il prend galement conscience de la ncessit - et, dans une certaine mesure, de sa capacit - rparer les milieux dgrads. Dans cette tude, lutilisation des images de tldtection du satellite ALSAT-1 du mois de Mai 2006 et qui ont subit diffrents traitements ont permets dvaluer la diversit cologique des forts naturelles des rgion semi arides et humides et identifier a linstant t les zones affectes par lincendie 2006. Lanalyse des compostes du milieu forestier a t rendu possible suite aux traitements spcifiques , dindice de vgtation et de classification multispectrale au models forestier .

Keywords: diverisite, teledetection, foret

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Hyperspectral SCIMACHY measurements and their application for cloud research

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Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY (SCIAMACHY) onboard ENVIronmental SATellite (ENVISAT) measures the spectral intensity of backscattered solar light in several observation modes, including limb, nadir, and occultation geometries. It has a high spectral resolution (typically, 0.2-0.5nm) and operates in a broad spectral range from 0.24 till 2.4 m. The broad spectral coverage coupled with a high spectral resolutions enables the determination of a number of cloud parameters such as the cloud top height (from oxygen A-band measurements), the cloud thermodynamic state (from the phase index equal to the ratio of reflectances at 1.55 and 1.67m), and also the cloud liquid water path and the effective size of droplets or crystals. The cloud fraction is retrieved using SCIMACHY polarization measurement devices. In this work, the correspondent retrieval algorithms and also the results of global retrievals are presented and discussed. The derived temporal trends in cloud properties for the time period 2002-2006 are studied. The validation of cloud products using ground, airborne, and satellite measurements is presented.

Keywords: clouds, solar light, radiative transfer

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JMS003 **Oral Presentation** **761**

Understanding variability of vegetation in Ethiopia using NDVI

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A ten-daily normalized difference vegetation index (NDVI) derived from the National Oceanic and Atmospheric Administration polar orbiting satellite from 1984-1999 are used to study the attributes and variability of vegetation in Ethiopia. Eigenvector analysis is applied on the standardized ten-daily NDVI across Ethiopia and its environs from 30-480E and 0-150N. The first three spatial modes obtained from the eigenvector analysis are used in Wards Cluster Analysis (WCA) to find out the vegetation regime across Ethiopia. The WCA clusters NDVI over Ethiopia into twenty different vegetation regimes. Each NDVI region is characterized in terms of mean, median, lowest and highest NDVI evolution. The time series from 1984-1999 on ten-daily bases is averaged over each NDVI regime and a wavelet analysis is applied on it to understand the mode of variability of vegetation in each region and identify remote, regional and in-situ mechanisms from intra-seasonal decadal timescale. Spin-off of the study is that it is possible to identify stable and unstable (highly variable) vegetation regime using wavelet analysis.

Keywords: ndvivariability, co operatingmechanisms, uniquenessofethiopianvegetati

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JMS003 **Oral Presentation** **762**

Global analysis and characterization of AIRS/MODIS Cloud-Clearing

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The Atmospheric Infrared Sounder (AIRS) and MODerate-Resolution Imaging Spectroradiometer (MODIS) on board the EOS Aqua spacecraft measure the upwelling infrared radiance used for numerous remote sensing and climate related applications. AIRS provides high spectral resolution infrared radiances while MODIS provides collocated high spatial resolution radiances at sixteen broad infrared bands. An optimal algorithm for cloud-clearing has been developed for AIRS cloudy soundings at the University of Wisconsin-Madison where the spatially and spectrally collocated AIRS and MODIS data has been used to verify this algorithm. A global analysis and characterization of the AIRS cloud-clearing using the bias and the standard deviation between AIRS cloud-cleared brightness temperature and the nearby clear brightness temperature are studied. The results have shown that about 21% of AIRS cloudy footprints are successfully cloud cleared, which make about 30% of FOVs clear for sounding. The synergistic AIRS/MODIS cloud-clearing performance in terms of bias and RMS error using collocated MOIDS clear and near by AIRS clear data have been characterized. The cloud-cleared radiances dataset along with their associated error estimates are to be delivered to Join Center for Satellite Data Assimilation (JCSDA) and Global Modeling and Assimilation Office (GMAO) for potential assimilation of AIRS cloud-clearing radiances.

Keywords: airs, modis, cloud clearing

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On the use of aster VNIR-SWIR data to map rock alteration associated with mineralization in Khetri Copper Belt, India

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Remote sensing is playing an increasingly important role in mineral exploration activity. Availability of high spectral and spatial resolution data is aiding search for hidden ore deposits in uncharted areas of the world. The surface expression of many important ore deposits is usually manifested as rock alteration of deep-seated (hypogene) or surficial (supergene) origin. The alteration minerals have distinct spectral features in the visible-, near-infrared (VNIR; 0.4-1.0 μm) and, more importantly, in the shortwave-infrared (SWIR; 1.5-2.5 μm) wavelength regions. The Advanced Spaceborne Thermal Emission and Reflection radiometer (ASTER) records data in 3 VNIR (15 m), 6 SWIR (30 m), as well as 5 thermal infrared (TIR; 90 m) bands. ASTER data are low-cost and are available worldwide with different levels of calibration and processing. The level-1B (L1B) data are available as geometrically and radiometrically processed radiance-at-sensor data. The level-2 (L2) data or the standard science data products include the surface radiance/reflectance and emissivity products for the VNIR-SWIR-TIR and TIR wavelength ranges, respectively. The study area is part of the Khetri Copper Belt (KCB) in northwest India. KCB is a structurally complex and regionally metamorphosed NNE-SSW striking linear (about 80 km long) polymetallic-sulfide mineralized belt consisting primarily of early Proterozoic metasedimentary rock units, and late Proterozoic basic and acidic intrusives. This belt has a base metal mining history of over two millennia, and is part of the North Delhi Fold Belt of the Delhi Supergroup of rocks. The oldest and dominantly psammitic Alwar formation (mainly pure and impure quartzites, and micaceous quartzites), and younger and dominantly pelitic Ajabgarh formation (mainly phyllites, schists, impure marbles and calc-silicate units) comprise the main lithologic units of the belt along with many small stocks, sills and dikes of granite, dolerite and amphibolite. The study area is marked by a prominent NNE-SSW striking shear zone long which numerous felsic (granitic and pergmatitic) intrusions have taken place. Small, but significant sulfide mineralization very close to the surface in a few places and in immediate vicinity of these intrusives makes this study area interesting to assess the potential of high-resolution remote sensing ASTER VNIR-SWIR data for exploration of potential alteration sites. Primary rock alteration in the form of sericitization, chloritization and carbonatization is widespread all along the shear zone. Secondary alteration due to weathering is common and is manifested as small gossans and limonitic surface coatings. This study uses ASTER L1B and L2 surface-radiance VNIR-SWIR data to identify and map these alteration minerals. The L1B data is first pre-processed to correct for SWIR crosstalk effects and inaccuracies in geolocation. Both relative and absolute atmospheric correction methods are tested to derive surface reflectances. Effects of topographic heterogeneities are corrected using the C-correction method. The pre-processed surface-reflectance/radiance data is then input to band ratioing and feature-oriented principal component selection (FPCS) procedures. Spectral analysis is carried out by determination of spectrally pure pixels using Pixel Purity Index (PPI) method and the use of spectral feature fitting (SFF) technique to identify the abundant mineral of pure pixels. The final alteration mineral maps are produced using Spectral Angle Mapping (SAM) and linear spectral unmixing classification techniques with spectra of pure pixels as reference. Ground-truth in the form of laboratory petrographic studies of GPS-controlled field samples is used to validate the results. An attempt is also made to correlate the spatial distribution of these minerals with the trace-metal content of rock samples in select locations.

Keywords: aster vnir swir, rock alteration, mapping

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Regional UV maps determined from groundbased measurements and cloud information from Meteosat

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So far, maps of the regional distribution of solar UV irradiance (usually weighted with the erythema action spectrum and presented in units of the UV-Index) are calculated from retrievals based on satellite measurements or from statistical interpolations between measurement stations at the ground. Now a new methodology was developed, which combines groundbased measurements with information on the cloud regional distribution, derived from MSG (Meteosat Second Generation) multispectral images. MSG data are processed to retrieve a 'cloud attenuation factor' (CLATF), defined as the ratio of the actual surface UV irradiance to what it would be in the absence of clouds. This attenuation factor is generated every 15 minutes with a spatial resolution of a few kilometres. Groundbased measurements are taken from the Austrian UVB monitoring network, which is operational since 1998 with 12 stations with broadband erythemal detectors. Annual recalibrations and continuous QC procedures guarantee a high level of accuracy. The data are collected in Innsbruck, where for each detector the individual calibration function in dependence on solar zenith angle and on total ozone is applied in near real time. The actual results are then displayed in the internet at www.uv-index.at. Daily a regional map is produced, which shows the maximal level of UV irradiance of the previous day in the area of Austria. The new methodology for the calculation of this map is build up of several steps: first the daily maximal values of the UV-Index at the measurement stations are selected. Then these measurements are compared with the results from model calculations for the same time period, assuming cloudless conditions, actual ozone levels, typical aerosols, typical ground albedo and the altitude of the station. This model value is reduced with the CLATF of the corresponding surface pixel of MSG. The ratio between the model result and the real measurement is usually different from one mainly due to errors in CLATF, whereas errors due to wrong amount of aerosols or ground albedo can be estimated and corrected under cloud-free conditions. The difference between measurement and calculation is varying with the measurement stations, resulting in individual correction factors. A smooth distribution of these correction factors over the whole area is calculated. Then the clear-sky irradiance is calculated for each pixel of a digital elevation map and the CLATF and its corresponding correction factor are applied. Thus a high resolution map is derived, which agrees at the measurement stations exactly with the measurements. Between the measurement stations the UV-Index is dominated by the distribution of the cloudiness as derived from the satellite, but the quantitative amount of the cloud effect is corrected due to the comparison at the measurement stations.

Keywords: uv map, uv measurements, meteosat

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JMS003 **Oral Presentation** **765**

Cirrus Variation with Sea Surface Temperature and Associated Climate Feedbacks

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The questions of whether tropical cirrus clouds increase or decrease with increasing sea surface temperature (SST) and whether they provide a positive or negative climate feedback have been the subject of intense debate. This study addresses these questions using new cloud observations from NASA A-train and other related satellite measurements. It is found that tropical mean cirrus cloud fraction from the Atmospheric Infrared Sounder (AIRS) on Aqua, when normalized by surface precipitation, tends to decrease with increasing underlying SST at a rate of about -20% per degree increase of SST. On the other hand, upper tropospheric (UT) cloud ice water content (IWC) observed by the Microwave Limb Sounder (MLS) on Aura shows an increasing tendency with increasing SST, at a rate slightly faster than the increase of surface precipitation with SST. Since IWC is directly linked to the optical depth of cirrus, its increase with SST must be considered in addition to cirrus cloud fraction change when examining the cirrus-climate feedback. Through a radiative transfer model calculation, we find that the MLS-observed UT cirrus (215 hPa and above) produce a net warming to the Earth-atmosphere system, about ~7.0 W m-2 on the tropical average. When IWC (and thus cirrus optical depth) is held constant, the decrease of cirrus fraction with increasing SST would produce a negative climate feedback. On the other hand, when the increase of IWC with SST is considered, the cirrus climate feedback becomes more complicated: it could change sign when IWC increases to a certain amount such that the net radiative effect of cirrus is dominated by its shortwave cooling. Therefore, the decrease of cirrus fraction with SST would lead to a positive climate feedback. We have also examined the UT water vapor (UTWV) and temperature changes over the tropical cloudy regions using the simultaneous UTWV and temperature measurements from MLS. The associated climate feedbacks will be discussed.

Keywords: cirrus sst, climate feedback

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JMS003 **Oral Presentation** **766**

Observation of Ocean Surface Stress over Ocean Fronts

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Xiaosu Xie, Pearn P. Niiler

Until the launch of the scatterometer, our knowledge of ocean surface stress (momentum flux) distribution is largely derived from winds measured at ships and buoys, or from operational wind product of numerical weather prediction centers, through a drag coefficient. Our present parameterization of stress in terms of wind is not sufficient over the regions of ocean fronts with strong horizontal current shear and temperature gradients. The backscatter power measured by a scatterometer is caused by small centimeter-scale waves on the surface, which are directly related to stress rather than wind. The geophysical product is call equivalent neutral wind (ENW), which by definition, has a unique relation to stress and not to wind. The collocation of high and low magnitudes of equivalent neutral wind (ENW) measured by QuikSCAT, with high and low sea surface temperature (measured by AMSR-E) over ocean fronts illustrates not only the stability dependence of turbulent mixing but also the unique stress measuring capability of the scatterometer. The observed rotation of ENW in opposition to the rotation of the surface current (measured by drifters) clearly demonstrates that the scatterometer measures stress rather than winds. The clear differences between the distributions of wind and stress affirm the critical need of surface stress vector measurements by the scatterometers. The opposite sign of the stress vorticity to current vorticity implies that the atmosphere spins down the current rotation through momentum transport. Co-incident high SST and ENW enhance evaporation and latent heat flux, which cools the ocean. The atmosphere is found to provide negative feedback to ocean current and temperature gradients. Distribution of ENW convergence implies ascending motion on the downwind side of local SST maxima and descending air on the upwind side, and acceleration of surface wind-stress over warm water (deceleration over cool water); the convection may escalate the contrast of ENW over warm and cool water set up by the dependence of turbulence mixing on stability. Collocation of SST anomalies with cloud-top temperature (provided by ISCCP) and atmospheric temperature profile (measured by AIRS) suggests long-term effect of ocean surface meso-scale features well above the mid-latitude atmospheric boundary layer, a phenomenon that has not been addressed in the past.

Keywords: ocean atmosphere interaction, wind stress, ocean front

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JMS003 **Oral Presentation** **767**

Global 9 km multi-satellite, multi-sensor sea surface temperatures from MODIS, AMSR-E, and TMI

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Current global sea surface temperature (SST) datasets do not take full advantage of the numerous satellites and different sensors now retrieving SST. Existing operational SST products depend on a single sensor to produce global datasets. This results in a lower spatial and temporal resolution than what is possible with a multi satellite, multi sensor SST analysis. Initial efforts indicate that blending data from different sensors requires much more rigorous bias and error characterization than is necessary when only including data from a single sensor type. Therefore, creating a high-quality multi-sensor SST requires careful inter-calibration of different satellite sensors, calculation of sensor-specific observation errors that consider environmental variables, location of observation, time of day, and sensor calibration problems; and development of techniques for relating and combining measurements at different spatial resolutions and times of the day. A global daily 9 km optimally interpolated SST has been calculated from MODIS, AMSR-E and TMI SST data. Initial methodology, validation results, and future work will be discussed. This improved global daily SST should be useful for a wide range of scientific and operational activities.

Keywords: sst

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JMS003 **Oral Presentation** **768**

Land-surface applications of long-term AVHRR data SERIES

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The AVHRR data set is one of the longest available from satellites and therefore predestinated for global change research. For land-surface applications, however, a homogenisation and calibration of the series obtained with different instruments is necessary. Methods have been developed to use these data world-wide for ecological research. Because of its topographic diversity the Mediterranean and central European area is ideally suited to test the accuracy and applicability of the products derived from these data. For this purpose the MEDOKADS archive was generated at the Free University of Berlin. It is a long-term, re-calibrated, homogenized, full resolution set of daily AVHRR data starting January 1, 1989, covering the area of 27 - 55 N, 10 W - 42 E. Originally developed to study desertification in the Mediterranean it has a range of other applications as well of which examples are presented. Basic or primary products are spectral reflectances averaged over a decade to remove cloud effects and radiometric temperatures. The long term data set allows to determine the variability, trends and regional synergies of surface temperature and reflectance related quantities. Combination of spectral reflectances leads to broad band reflectances and to vegetation indices. These are related to vegetation density, vegetation period, and changes of land use. Further data aggregation eventually under inclusion of higher (Landsat, SPOT) and lower (Meteosat) resolution satellite data as well as of supplemental ground observations leads to higher order data products. The combination of shortwave and longwave infrared data allows to determine the extent of droughts, heat waves, and fires. More elaborate evaluation of the data leads to albedo and the energy budget at the surface. Part of this is the latent heat flux from the surface, a component of the hydrological cycle. Combination with models finally allows to study changes of ecosystem and hydrological processes. Discussed are also limitations for the application of the data. Aerosol effects play a major role in the Mediterranean: Frequent desert dust outbreaks, industrial pollution and burning and volcanic eruptions cause a high variability of atmospheric turbidity. The local time difference between the eastern and western edge of the swath results in different illumination geometries and surface temperatures. This requires an in principle pixel-wise correction according to the bidirectional reflection function of the surface in the shortwave AVHRR channels and a normalization of the radiometric surface temperature. Orbital drifts cause additional problems. Notwithstanding a careful re- and inter-calibration there remain irregularities in the data base probably caused by variations of the sensor sensitivity. To correct for such effects, inter-comparisons with other satellite data from shorter term missions and with surface measurements at anchor stations are necessary. Validation studies have been carried out in a number of places in the Mediterranean area.

Keywords: long term avhrr data series, land surface processes, global change studies

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Climatic Features of Cloud Water Path Over China

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Analysis of cloud water path (CWP) data over China available by the International Satellite Cloud Climatology Project (ISCCP) is performed for the period 1984-2004. The climatology, trends, and variability of CWP are examined. The climatological distribution and variation of CWP are dependent on the circulation, especially the monsoon circulation, topography and atmospheric moisture. Influenced by the Asia monsoon, China's CWP exhibits very large seasonal variations. All-China average shows the maximum CWP in June and the minimum CWP in October. Under the influences of the Tibetan Plateau and the westerly flow, the largest CWP is found in winter and early spring in the southeastern China. Linear regression analysis is used to characterize seasonal and annual trends in CWP. Increasing trends in CWP are observed over much of China. The northwestern China, especially over the Tibetan Plateau, and the Inner Mongolia show significant increases of CWP. The largest increase in CWP is in winter and the increasing trend is weakest in spring. These increases in CWP are primarily dependent on the enhanced updraft deduced by the variation of circulation, including the weakening of the summer monsoon system. According to the EOF analysis, step-like increase in CWP is also found (EOF1) during 1984-2004 and the variation of CWP is statistically significant correlated with the North Atlantic Oscillation (NAO) in EOF2. Interannual variation and trends in CWP and water vapor are closely correlated in China, confirming the enhanced hydrological cycle under the background of global warming. The correlations among CWP, water vapor and precipitation in the southeastern and the northwestern China are investigated. In summertime the higher correlation are found between CWP and precipitation than that between water vapor and precipitation in the both regions.

Keywords: isccp, cloud water path, climatic features

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The impact of the 2002-3 Australian dust storm season on phytoplankton growth and CO2 drawdown in the Southern Ocean: evidence for a natural Fe- fertilization event

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In so-called High Nutrient Low Chlorophyll (HNLC) regions such as the Southern Ocean (SO) south of the Australian continent, mineral dust-borne micronutrients, such as iron (Fe), are thought to limit primary production, control phytoplankton species composition, and potentially the transfer of carbon to the deep ocean, thus, affecting atmospheric CO2 concentrations. The austral spring-summer of 2002-03 was characterised by unusually high dust storm activity in Southern Australia, and synoptic meteorological patterns that transported the dust south and east over the SO. We present a suite of satellite ocean colour and aerosol optical depth data, together with modelled air parcel trajectories, suggesting that dust plumes were frequently transported over extensive parts of the SO, as far south as 50S. Contemporaneous data on surface ocean chlorophyll from several cruise transects between Hobart and Antarctica corroborate the satellite ocean colour data. Importantly, data on pCO2 collected during these transects indicate that the increased algal biomass was accompanied by significant CO2 draw down between 50 and 60S. The data sets point to the occurrence of several large-scale natural ocean fertilization events, during this period, and provide clear documented examples of natural, large-scale Fe-fertilization events, supporting the results of various artificial perturbation experiments conducted in the equatorial Pacific and SO. We conclude that mineral dust from the Australian continent exerts an important influence in the SO ecosystem, and together with other continental sources, may provide a key climate feedback loop linking the lithosphere, atmosphere and ocean.

Keywords: phytoplankton, aeolian dust, carbon cycle

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An End to End Satellite Data Processing Software Package for Direct Broadcast Users

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The International MODIS/AIRS Processing Package (IMAPP) has been providing EOS Terra and Aqua direct broadcast users with the capability to calibrate and navigate locally received satellite data and producing real time products since 2000. The current package now contains collection 5 software which will create MODIS products including: 1) calibrated/navigated radiances, 2) cloud mask, cloud top properties, 3) cloud phase, 4) retrievals of atmospheric profiles, 5) total precipitable water vapor, 6) aerosol optical depth, 7) sea surface temperature, and 8) a near-infrared technique to determine atmospheric water vapor. In addition, the package also includes AIRS sounder suite calibration and navigation software for the AIRS and AMSU instruments. Two complimentary techniques for generating temperature and moisture profiles from the AIRS Sounder suite have now been added, one using a physical based algorithm and the other a clear sky only statistical algorithm at single AIRS pixel resolution. Finally, AMSR-E calibration and navigation software is available along with science production software for generating rain rate and soil moisture. Beyond the EOS direct broadcast software development, distribution, and user support. IMAPP team at CIMSS/UW also have conducted training workshops to educate software users in general remote sensing principal, sensor characteristic, data processing technique, processing algorithm, product applications, and real time utilities. In this presentation we will overview the current status of IMAPP and its future expansion to include METOP and NPP/NPOESS data processing capability.

Keywords: end to end, imapp, direct broadcast

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JMS003 **Oral Presentation** **772**

MetOp-A: The first meteorological polar operational European satellite

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MetOp-A, forming the space segment as part of the EUMETSAT Polar System (EPS), is the first meteorological operational European satellite in polar orbit; it was developed by the European Space Agency on behalf of EUMETSAT and successfully launched on 19/10/2006. MetOp-A is the first in a series of three satellites to provide more than 14 years of Earth observation for weather and climate prediction. EPS is the European contribution to the Initial Joint Polar System (IJPS), a joint European-US satellite system. Both constellations space components carry the meteorological core instruments AVHRR, HIRS, AMSU-A, MHS. MetOp-A in addition carries the innovative IASI hyperspectral IR sounder, ASCAT, GRAS, and GOME instruments. Instrument data is provided in Near-Real-Time (within 2h 15 min) to the user community. This presentation will give an overview on the EPS System and the MetOp satellite in particular. Instrument data and products, dissemination, and the expected impact of MetOp on Numerical Weather Prediction will be covered.

Keywords: metop, nwp

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JMS003 **Oral Presentation** **773**

The Altius mission

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The possibility of atmospheric remote sounding through the limb scattering of solar light has been recently demonstrated by a few spaceborne instruments. Accurate vertical information about O3, NO2, water vapour and aerosol number density profiles can be retrieved from the limb radiance measurement in the UV-VIS-NIR spectral range. The Belgian Institute for Space Aeronomy has performed a feasibility study for a limb spectral imager named ALTIUS on board a dedicated micro- satellite. The instrument acronym ALTIUS means "Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere" and the mission originated in a reaction to the dramatic decrease in the number of forthcoming atmospheric sounders with a good vertical resolution. This instrument will fundamentally differ from classical grating or prism spectrometers by making use of acousto-optical tunable devices in front of 2-D detectors. This will allow to address one of the major difficulties in the limb scattering technique, i.e. the correct determination of the tangent altitude along the line-of-sight. Also, in order to fully optimize the observation time, ALTIUS will be allowed to observe solar and stellar occultations in an inertial pointing mode. The rationale and the expected performance of the instrument will be presented at the conference.

Keywords: limb, sounding, stratosphere

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JMS003 **Oral Presentation** **774**

Development of a Fire Information System: Monitoring fires underneath transmission lines

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Hein Vosloo, Diane Davies, Prof Harold Annegarn

The Advanced Fire Information System (AFIS) is the first near real time operational satellite fire monitoring system of its kind in Africa. The main aim of AFIS is to provide information regarding the prediction, detection and assessment of fires using Remote Sensing and open source GIS technology through an automated near real time Web GIS portal. Limitations in satellite technology forced Fire Information Systems to largely focus on the global change research community where non real time fire frequency and distribution data could be utilized. In 2002 damages to infrastructure and loss of grazing due to wild land fires in South Africa were estimated to be in the region of $ 50 million. An urgent need was identified to develop a satellite based information system that could provide information on the frequency and distribution of fires over time for the change detection research community but also provide a near real time tool that could provide early detection of fires to fire managers. The South African National Department of Agriculture provided seed funding to upgrade the CSIR Satellite Applications Centre (SAC) facilities to receive and process Moderate Resolution Imaging Spectro-radiometer (MODIS) imagery. In 1999 and 2002 NASA launched the Terra and Aqua satellites, which both carries MODIS. These sensors scan the earth eight times a day in 36 spectral bands including a mid infra red band dedicated to fire detection. Coupled with MODIS data, Meteosat Second Generation (MSG) geostationary satellite data are providing fire location information every 15 minutes feeding AFIS to with continuous fire detections day and night AFIS has been developed in collaboration with the University of Maryland and NASAs Earth Observation Systems. The main funding for the development and implementation of AFIS came from South Africas biggest power company - ESKOM. Wild land fires underneath power lines can cause flashovers (arcing between the line and the ground) which severely affect industries electricity supply. ESKOM and the CSIR commenced research to investigate the affectivity of the MODIS and MSG satellite sensors to detect fires that could cause flashovers on the 28 000 km of transmission lines of South Africa. ESKOM implemented AFIS in June 2004, scanning a buffer of 5 km along all transmission lines searching for any fire hot spots at 15 minute time intervals. With the detection of a fire, email and SMS text messages are created and send to relevant authorities in near real time. The effectiveness of the system is based on the ability of the MODIS and MSG sensors to detect fires before a flashover occurs. By comparing known fire flashover statistics from 2003 2006 with actual MODIS fire detections for the same period we see that MODIS detects in the region of 40% of all flashover fires. For MSG statistics shows that close to 50% of all flashover fires are detected. By combining the 2 satellite sensors the detection accuracy increases to more that 60% for the 2003 2006 period. The higher spatial resolution from MODIS enables the detection of smaller fires but due to its limited temporal frequency, it missed a lot of fires between overpasses. The MSG sensor misses a lot of the smaller fires due to its coarser spatial resolution, but its ability to update every 15 minutes enables the detection of fires that the polar arbiters can not see. Additional to the detection of active fires, the MODIS and MSG sensors are also used to derive a near real time Fire Weather and Fire Danger Index. Air temperature and relative humidity are estimated from real time MSG thermal data to generate a burning index. A regression tree was used to create the predictive model based on multiple inputs from MSG and MODIS. The burning index is combined with interpolated wind fields which generated the Fire Weather Index. The Fire Weather Index is combined with a grass curing index to generate the Fire Danger Index.

Keywords: fire, monitoring, satellites

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Global Ocean Circulation and Sea Level from Satellite Observations

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Over the past half century the ocean has absorbed over 80% of the surplus of heat input to Earth resulting from global warming. However, the data collected in the past were not sufficient to answer questions like: How is the heat distributed in the ocean and how much longer is the ocean able to maintain its current rate of heat uptake? How fast is sea level rising caused by the heating? These are important questions whose answers are key to understanding the oceans role in climate change. Observations from satellites using a radar altimeter to measure sea surface height (SSH), a technique called satellite altimetry, have gone a long way towards addressing these questions. The first altimeter for studying the ocean was launched onboard Seasat in 1978. The 3-month long mission demonstrated the potential of the technique. However, it took more than a decade to launch the Joint U.S./French TOPEX/Poseidon Mission (T/P) in 1992, which marked the beginning of precision altimetry with sufficient accuracy for studying the large-scale patterns of ocean circulation and global sea level change. The data record established by T/P was continued by its follow-on US/French Jason Mission in 2002. This combined 14 plus year record of SSH has provided the first global view of the change of ocean circulation and sea level on decadal scales. Ocean circulation is found to be tied to major modes of climate variability such as the Pacific Decadal Oscillation. Basin-scale patterns of decadal variability are determined in all ocean basins. Such variability is not only interesting in its own right; it must also be taken into account in the determination of longer-term trends in global sea level change. The combination of the observations from Jason and GRACE, a satellite measuring Earths gravity field, allows the separation of sea level change into contributions from mass and density change of the ocean. The density change of the ocean from heating/cooling provides information on the oceans heat storage. With the approach of modeling and data assimilation, the vertical distribution of the heat storage can be determined. In addition to T/P and Jason, the European Remote Sensing (ERS) Satellites and their replacement, ENVISAT, have provided complementary data leading to enhanced spatial and temporal resolution of SSH observations. Significant advances have also been made in the understanding of the mesoscale variability of the ocean that contains most of the kinetic energy of the ocean. The continuation of the SSH data record using conventional and advanced altimetry techniques will also be discussed.

Keywords: ocean circulation, sea level, altimetry

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Contribution of spatial altimetry to hydrology: the CASH project

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Most of the great fluvial basins in the world are located in emergent or undeveloped countries, and their majority are trans-boundary. Therefore, a global water monitoring system using spatial radar altimetry could be of great interest. Radar altimetric satellite missions have covered the earth with a dense measurement network during the last decade and could provide historical record as well as fast-access data of continental water stages. So far, not a single satellite mission has been devoted to continental water. Most of the studies over great rivers and lakes have been conducted by spatial field specialists and hydrologists have not yet widely used altimetric measurements in hydrological models or water monitoring studies. The aim of the CASH project was to study the way the hydrologists could used these data, as limited as they presently are, due to their dedication to ocean or ice studies. The first task of the project was to organize the data in a structure similar to that of the hydrometric in-situ records. This imposed to create the notion of "virtual gauge", being the crossing area between the satellite ground track and the river. Then two types of data processing specific for continental waters have been conducted: retracking of raw data and environmental correction, both adapted to the case of continental waters. Last, integration of altimetric data into hydro-dynamical modelling has been performed. The main results are the production of rating curves at virtual gauging station, the retrieving of the water depth from the water surface elevation, the spatially distributed discharge at the virtual stations, the estimation of water stage and discharge for very poorly gauged basins and the estimation of the water volume temporal variation within the floodplains.

Keywords: radar altimetry, hydrology, tropical basins

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JMS003 **Oral Presentation** **777**

The cloud cover effect: have we been overlooking the dominant term in climate uncertainty?

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Shallow marine stratocumulus has been at the focus of climate change research because these clouds are most susceptible to albedo enhancement by aerosols and they cover large area. Re-examination of recent studies analyzing AVHRR comparisons of aerosols with the albedo and cover of these clouds (Sekiguchi et al., 2003) revealed that the forcing at TOA due to increased cloud cover, FC, is more than 4 times greater than the forcing due to enhanced cloud albedo, FA. Manipulating the MODIS based observations (Kaufman et al. 2005) implies even stronger effects that further revolutionize our understanding of cloud-aerosol interactions. It is inferred that FA is < 20% of the combined cloud forcing (FC+FA). Only about half of FA, i.e., ~10% of the combined cloud forcing, can be explained by the Twomey effect (which was previously believed to be dominant), i.e., due to increasing cloud droplet numbers for a fixed amount of cloud water. The other half of FA can be explained by decreasing loss of cloud water to precipitation with higher aerosol concentrations. The depletion of cloud water by rainout in pristine conditions appears as a very strong mechanism to wipe out clouds. As already has shown by Albrecht, aerosols increase cloud cover by prolonging their life. An amplification mechanism responsible to the great sensitivity of cloud cover to very small changes of aerosols in the MBL at near pristine levels was proposed by means of switching between the regimes of closed and open cellular regimes (Rosenfeld et al., 2006). This is a manifestation of the sensitivity of the cloud cover to the logarithm of the aerosol loading. This process was not incorporated yet in climate models, but the radiative forcing due to this mechanism is so large that it must imply that yet another strong positive forcing is not taken into account in the climate models. A possible process that can potentially address this question is the aerosol effect of invigorating deep convective clouds (Rosenfeld, 2006) that develop to greater heights and transport more condensates and water vapor to the upper troposphere and lower stratosphere (Sherwood, 2002). The added water vapor and thin cirrus at these heights has strong positive forcing at TOA that might be compensating the strong negative forcing of the aerosol effects on the low clouds. Incorporation of such processes in climate prediction models is essential for their skill to predict future climate scenarios. REFERENCES: Sekiguchi, M., T. Nakajima, K. Suzuki, et al., A study of the direct and indirect effects of aero-sols using global satellite data sets of aerosol and cloud parameters J. Geophys. Res, 108, NO. D22, 4699, doi:10.1029/2002JD003359, 2003 Kaufman Y.J., I. Koren, L. A. Remer, D. Rosenfeld, Y. Rudich, 2005: Smoke, Dust and Pol-lution Aerosol Clouding the Atlantic Atmosphere. Proceedings of the National Academy of Sciences, 102, 11207-11212. Rosenfeld D., 2006: Aerosol-Cloud Interactions Control of Earth Radiation and Latent Heat Release. Space Science Reviews. Springer, 9p. 6 December 2006. DOI: 10.1007/s11214-006-9053-6. Rosenfeld D., Y. Kaufman, and I. Koren, 2006: Switching cloud cover and dynamical regimes from open to closed Benard cells in response to aerosols suppressing precipitation. Atmos. Chem. Phys., 6, 2503-2511. Sherwood, S.C. A microphysical connection among biomass burning, cumulus clouds, and stratospheric moisture. Science, Vol. 295, No. 5558, 2002, pp. 1272-1275.

Keywords: aerosols, clouds, precipitation

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JMS003 **Oral Presentation** **778**

Antarctic Satellite Usage and Applications

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Satellite observations over the Antarctic and adjacent Southern Ocean are critical for weather forecasting in support of logistic operations as well as a major tool for observing and learning about the behavior of the Antarctic atmosphere. Polar orbiting satellites have been and remain the primary observing platform providing critical operational support as well as long-term monitoring, and offering inspiration for new developments. The status of modern satellite product generation and processing at McMurdo Station, Antarctica such as cloud products (cloud phase, cloud top pressure, etc.) and automated motion vectors (AMV) from the Aqua and Terra satellites Moderate-resolution Imaging Spectroradiometer (MODIS) will be reviewed. Applications, benefits and use of these modern and traditional polar orbiting satellite observational datasets will be outlined along with current and future data distribution plans. This year marks the 15th year the University of Wisconsin-Madison has been generating Antarctic composite imagery using a combination of geostationary and polar satellite source observations. The latest updates to the composite will be reviewed including discussion on the inclusion of new satellites, increased temporal frequency, as well as derived product efforts underway and planned. The archival, distribution, and sample application of the composites will also be reviewed in this presentation. Additional spectral channels will be debuted as recent expansions to the effort.

Keywords: satellite, antarctica, observations

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JMS003 **Oral Presentation** **779**

Monitoring the impacts of Climate Change/ Variability and Anthropogenic Activities on Lake Chad, Northeastern Nigeria, Using remote Sensing Satellite

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Using remote sensing data obtained from NigeriaSat-1 and annual rainfall data (1940-2003), the extent of impacts of climate change/variability (drought) and irrigation activities on the lake were investigated. Results show that there has been decreasing trend of rainfall and a southward shift in the isohyets and resultant encroachment of desertification over the area. Consequently, there is shrinkage in the Lake size from 25,000km2 in the 1960s to presently barely 2,000km2(i.e. 1/10th of the size it was 35 years ago), with an average depth of 4m. The concomitant effects of the prolonged drought conditions are also captured chronologically in the satellite imageries used, which correlates very well with the effects of prevailing rainfall regime. It is further observed from the imagery that in 1973, the lake level reduced dramatically, and the lake system split into three separate water bodies. Rainfall was below normal, and this coincided with the period of El-Nino episode of 1972/73. Also, irrigation development in the lake Chad Basin has been carried out by and in all the four riparian nations sharing the basin; much of which is uncoordinated and thus affecting flows into the lake.

Keywords: lake chad, satellite imagery, isohyets and climate change

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JMS003 **Oral Presentation** **780**

The Space Age of Biological Oceanography

Dr. Mike Beherenfeld
IAMAS

The oceans are truly enormous. From the birth of biological oceanography as a science discipline, field studies on marine ecosystems and organisms were largely constrained to measurements conducted from ships. Research vessels, however, only travel at about the speed of a bicycle, making observations sparsely distributed despite a century of sampling and leaving vast regions of the oceans unexplored. The space age of biological oceanography commenced only decades ago and from this view at the top of the atmosphere our understanding of ocean biology and its intimate relationship with the physical-chemical environment has been revolutionized. While the initial prime objective for ocean color remote sensing was the quantification of surface layer chlorophyll concentrations, we have since expanded our suite of derived products to include such properties as phytoplankton carbon biomass and growth rates, concentrations of colored dissolved organic material and total particulate carbon, and even distributions of key functional groups in the ocean carbon cycle, including calcifying organisms and nitrogen fixers. With our growing satellite record, we are now beginning to also resolve relationships between ecosystem variability and climate fluctuations. In this presentation, a subsample of the many highlights from ocean remote sensing will be reviewed, along with directions for future research and challenges faced because of an aging and outdated fleet of satellite ocean color sensors.

Keywords: satellite, ocean, biology

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JMS003 **Oral Presentation** **781**

Direct Characterisation of Potential Dust Source Properties in the Bodl Depression by means of Remote Sensing

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Atmospheric aerosols, especially mineral dusts have been recognized to play a key role in the Earth radiation balance. By scattering or absorbing incoming solar radiation, mineral dusts contribute to the cooling or a warming of the Earths climate. These proper characteristic of dusts are linked to their mineralogical, physical, and chemical properties. With the goal to establish high developed climate model, the knowledge of dusts properties, especially those of the Sahara and Sahel is a primordial for the meteorology. MegaChad that extends from the central Sahara to the Sahel zone is characterized by large variability of bared surfaces. Inside this vast and arid area, the Bodl Depression (BD) in its northern part constitutes the world biggest mineral dust source. This primacy of the BD in mineral dust regeneration is due to the geophysical environment dominated by the Tibesti massive that allows to reinforce and channel strong Harmattan winds on the vast extended Paleo-Lake sediment surfaces. Due to the vastness of the region and difficulties to explore all the area by surface samplings, it is an urgent need to develop a new approach based on the use field and orbital remote sensing to characterize dust sources properties. On the base of singles and combined IRS and Landsat 7 ETM+ bands, it was possible to established high correlations between surface sample properties and their spectral signatures. The results show approaches to characterize the main dust sources in the MegaChad and to estimate dust fraction, total iron, and most important minerals and their influence on absorption of the visible and infrared radiation.

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JMS003 **Oral Presentation** **782**

Interannual Variability of Regional Tropospheric Ozone Pollution: Extending the Data Record into the Next Decade

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Using observations that span more than two decades starting in 1979, Fishman et al. [2005, J. Geophys. Res., doi:10.1029/2005JD005868] showed that there is a significant correlation between regional air pollution and the El Nio/Southern Oscillation (ENSO) in both northern India and western Africa. The study employed tropospheric ozone column amounts derived from total ozone measurements from the Total Ozone Mapping Spectrometer (TOMS) in conjunction with observations from corrected Solar Backscatter Ultraviolet (SBUV) observations to separate the stratosphere from the total column; the resultant product is commonly referred to as the tropospheric ozone residual (TOR). Monthly averages of TOR (http://asd-www.larc.nasa.gov/TOR/data.html) were then analyzed to investigate the correlation between TOR amounts in a number of polluted regions and several ENSO indices. With the launch of NASAs Aura satellite in July 2004, daily global total ozone distributions are now provided by the Ozone Monitoring Instrument (OMI). This paper will focus on the development of a quasi-continuous TOR database derived from TOMS and OMI and examine the differences and consistencies between the TOR data sets derived using these two instruments to determine the feasibility of extending the TOR database through the life of the OMI instrument. Both TOMS and OMI measurements are available for the entire year of 2005 and TOR distributions using several methodologies can be derived using information from several other sources. To calculate the integrated amount of ozone above the tropopause, the stratospheric column ozone (SCO) will be calculated using ozone profile information from the Microwave Limb Sounder (MLS) aboard Aura, as well as from SBUV, and from a model-derived SCO product derived from NOAAs Global Forecast System (GFS) ozone/transport model. Methods for validation of these data records will be discussed.

Keywords: tropospheric ozone, interannual variability, regionalpollution

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JMS003 **Oral Presentation** **783**

Recovering the data from the damaged HIRDLS Instrument

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John Barnett, Charles Cavanaugh, James Craft, Cheryl Craig, Vincil Dean, Thomas Eden, David Ellis, Chris Halvorson, Craig Hartsough, Chris Hepplewhite, Rashid Khosravi, Hyunah Lee, Bruno Nardi

The High Resolution Dynamics Limb Sounder (HIRDLS) is a 21 channel IR limb sounder designed to measure temperature, ozone, water vapor and 8 other gases as well as particulates with finer vertical resolution than previously available. During launch on the Aura spacecraft a piece of the plastic film liner that had been inserted to maintain the cleanliness of the optics apparently came loose, and lodged in such a way that it contacted the scan mirror while blocking a large part of the entrance aperture. Efforts to dislodge it were unsuccessful. The HIRDLS team has devoted a major amount of effort to correcting the observed signals to extract the atmospheric component. Effects that needed to be corrected included the calibration of signals, oscillation of the blockage due to scan mirror motion, correction for the reduced viewing area, and the varying signal due to reflection and emission by the blocking film. All of these (and other) effects will be discussed, but major emphasis will be on the correction for the blockage signal. This required constructing a 3 step physical model of the signal mechanism, then determining the required parameters from a few orbits in which the spacecraft was pitched 5.25, so that there was no atmosphere or earth signal in the observed signal. The results indicate that the correction is close to the noise level. Retrieved results for water vapor and other species indicate good results around the orbit, and show the expected high vertical resolution. Some remaining problems will be noted.

Keywords: hirdls, instruments, datarecovery

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JMS003 **Oral Presentation** **784**

Simulations of space-borne Doppler observations

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Space-borne Doppler radar observations of clouds are scientifically very interesting, but the correct interpretation of the measurements is challenging. Global observations of vertical velocity in cloud systems in many different climate zones will improve our understanding of large-scale convective motions and cloud microphysics. Unfortunately, observed Doppler speeds are a complex weighted average over all line-of-sight velocities within the radar's field-of-view. As the large orbital speed of the radar contributes to these line-of-sight velocities, cloud inhomogeneities can cause significant deviations in Doppler speed from the true vertical speed. EarthCARE is a proposed ESA/JAXA space mission dedicated to cloud and aerosol studies. The mission will consist of an VIS and NIR imager, a 95 GHz Doppler radar, a 355 nm lidar and a broadband radiometer all on the same platform and optimized for synergetic cloud & aerosol studies. EarthCARE will be the first space mission with a cloud profiling Doppler radar on-board. To assess the accuracy of EarthCARE's Doppler observations, we have developed a new Doppler radar simulation technique that deals consistently and effectively with cloud inhomogeneity. The technique is faster than the IHS (Individual Hydrometeor Simulation) technique and more versatile than the traditional inverse FFT (Fast Fourier Technique) technique. Using realistic cloud scenes derived from ground-based Doppler radar systems, the accuracy of the 95 GHz Doppler radar proposed for the EarthCARE space-mission was assessed. It is shown that within clouds, the required accuracy of the Doppler observations is not always met. For ground-tracks of 1 km, 10 % of the observations with Z > -20 dBZ has a deviation > 1 m/s from the truth, and for ground-tracks of 10 km 30 % has a deviation > 0.2 m/s from the truth. For observations near lateral cloud boundaries, errors can easily amount to several m/s. A correction algorithm is proposed based on the horizontal gradients in observed reflectivity. For the cases considered sofar, the algorithm seems capable of sufficiently correcting for the biases caused by cloud inhomogeneity. Based on this finding, the required along-track sampling distance of the EarthCARE radar was recently decreased from 1000 m to 500 m.

Keywords: doppler radar, simulation, earthcare

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JMS003 **Oral Presentation** **785**

Measurements of Tropospheric Composition from Space: What Have We Learned? Where Are We Going?

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Since the 1980s, satellite instruments have attempted to probe the troposphere to enable us to learn about global and regional pollution issues. In the intervening time, great progress has been made in this area and we now have the means to measure several gases such as carbon monoxide, ozone and nitrogen dioxide on a regular basis. These instruments, flown on several different satellites have given us considerable insight into many issue surrounding global sources, sinks and transport. It is clear that environmental issues will become more pressing as the planet becomes more heavily industrialized and it will be necessary not only to monitor the situation, but to act preemptively to ensure that ecosystems is not adversely affected by human activities. This talk will briefly review what we have learned in the last 20 years, especially as it applies to what will be needed in the future. We will discuss new satellite systems in several orbit configurations, and the development of new instrumentation to tackle these pressing problems.

Keywords: satellite, pollution

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JMS003 **Oral Presentation** **786**

One decade of pyrogenic NMVOC emissions deduced from HCHO satellite data

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Formaldehyde columns retrieved from the GOME and SCIAMACHY instruments between 1997 and 2006 are used together with the IMAGES global chemistry transport model to provide top-down estimates for biomass burning and biogenic NMVOC emissions on the global scale. The formaldehyde retrievals use the differential optical absorption spectroscopy technique. Altitude-resolved air mass factors are consistently applied to formaldehyde profiles derived from the CTM. In view of the large number and diversity of NMVOCs involved in the production of HCHO, a preliminary study has been conducted using quasi-explicit chemical mechanisms (mostly from the Master Chemical Mechanism, MCM) in order to determine the formaldehyde yields in the oxidation of the most prominent NMVOCs (> 20 compounds). These results have been used to optimize the chemical mechanism of the CTM with respect to formaldehyde production. Pyrogenic emissions are speciated according to Andreae (2007). Prior estimates of monthly burnt biomass between 1997 and 2006 are provided by either the GFEDv1 or GFEDv2 database of van der Werf et al. (2006). Fire emissions show a strong diurnal cycle, with a peak in the afternoon, and little emissions at night and in the early morning. Gridded diurnal profiles are derived by extrapolating the estimated diurnal profiles from the detailed study of Giglio (2007). Their impact on the modeled HCHO columns at 10:30 AM local time (the satellite overpass time) will be discussed. Total pyrogenic NMVOC emissions and total biogenic emissions are optimized using the grid-based approach, previously applied to the optimization of CO sources by Stavrakou and Muller (2006). In this framework, the emissions are optimized at the resolution of the CTM (5 degrees). Given the large number of emission parameters to be optimized (~200,000), source-specific spatial and temporal correlations among errors on the prior emissions are essential in order to reduce the number of effective unknowns. We found a good agreement between our model and measurements in most sites. In several regions however, the model results deviated from measurements, highlighting the potential of satellite data for further constraining biogenic and pyrogenic emissions.

Keywords: formaldehyde, nmvoc emissions, inversion

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JMS003 **Oral Presentation** **787**

AIRS-Enabled refraction modeling in SLR using ray tracing

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Atmospheric refraction is an important accuracy-limiting factor in the use of all space-based geodetic techniques, and suffers from limitations in current refraction models. The current modeling in the analysis of Satellite Laser Ranging (SLR) data comprises the prediction of the atmospheric delay in the zenith direction from surface conditions and projection to the observations elevation angle, using a mapping function. A new zenith delay model of sub-millimeter accuracy [Mendes and Pavlis, 2004] and a new mapping function of sub-centimeter accuracy [Mendes and Pavlis, 2002] were recently developed, applicable to the wavelengths used in modern SLR instrumentation. Using 2-D ray tracing and globally distributed data from the Atmospheric Infrared Sounder (AIRS), the European Center for Medium Weather Forecasting (ECMWF) and the National Center for Environmental Prediction (NCEP), we validated the new zenith delay model and mapping functions. These however are still far from the desired sub-millimeter accuracy goal for future SLR analysis standards. To further improve the atmospheric delay models, we now look at the effects of horizontal refractivity gradients on SLR data collected at core SLR sites around the globe. We discuss the effects of using different types of input data for the ray tracing (AIRS, ECMWF and NCEP), and the effects of seasonal and diurnal changes, latitudinal dependence, topography and large bodies of water on the delay due to horizontal gradients. We also present a complete analysis on the effects of using ray tracing to compute the total atmospheric delay, including horizontal gradients on a set of SLR data (2004 to 2006) from two geodetic satellites, LAGEOS 1 and 2 and for 10 of the most significant SLR sites around the globe. We also discuss plans for incorporating in the weekly SLR analysis these new corrections in a near-real time operational mode for increased spatiotemporal resolution and improved SLR products.

Keywords: refraction, slr, airs

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JMS003 **Oral Presentation** **788**

Basic Radar Altimetry Toolbox & Tutorial

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The field of satellite radar altimetry has matured to a point where it is now time to encourage a multimission approach (between various altimetry systems) and conceive an all-altimeter toolbox and tutorial. Such an integrated approach and view is vital not only for assessing the current status of what offers altimeter products but also to show the system and consistency with the past. The Basic Radar Altimetry Toolbox (BRAT) is a collection of tools, tutorials and documents designed to facilitate the use of radar altimetry data for altimetry users, experienced as well as beginners, and particularly the users of the upcoming CryoSat mission. It is able - to read most distributed radar altimetry data, from ERS-1 & 2, Topex/Poseidon, Geosat Follow-on, Jason-1, Envisat, and the future Cryosat missions, - to perform some processing, data editing and statistic, - and to visualise the results. As part of the Toolbox, a Radar Altimetry Tutorial gives general information about altimetry, the technique involved and its applications, as well as an overview of pas present and future missions, including information on how to access data and additional software and documentation. It also presents a series of data use cases, covering all uses of altimetry over ocean, cryosphere and land, showing the basic methods for some of the most frequent manners of using altimetry data. BRAT has been developed under contract with ESA and CNES. It is available at http://earth.esa.int/brat and www.altimetry.info

Keywords: radar altimetry

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JMS003 **Oral Presentation** **789**

A satellite-based study of the propagation of deep convection over central Africa

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Deep convection in central Africa is examined as part of a broader study to characterize warm season, continental precipitation across the globe. Warm season, continental rainfall is often produced from long-lived episodes of organized convection. Carbone et al. 2002 [JAS] used radar data to demonstrate that organized convection in North America is comprised of phase-coherent sequences. Satellite products are the only available data for continental scale studies in other regions. Through the use of geostationary infrared data, similar patterns of inferred warm-season rainfall have been reported for East Asia, , northern tropical Africa, and Europe. A climatology of convective episodes over central Africa is derived using digitized images from the European geostationary satellite (Meteosat). The infrared images have a spatial resolution of 5km at the satellite sub-point and are available at 30 minute intervals. The images are sampled to a 0.2 grid for the central African domain, which covers 15S to 15N and 20W to 45E. The large domain is divided into smaller zones for the autumn and spring transitions. Hovmoller strips are drawn through each domain and thresholds of 233K are used to identify the cloud systems that are most likely to be precipitating. The mean diurnal cycle is determined by computing the occurrence of precipitating convection at a particular longitude for each hour. Global analyses are used to analyze the large-scale environments associated with deep convection. Those data are on a 1-degree grid and provided daily at 0000, 0600, 1200, and 1800UTC. A large fraction of episodes have their origin in the lee of the mountains of East Africa. A major generating factor is thermal forcing associated with large scale elevated heat sources. Most episodes propagate westward across the continent with some highly organized systems undergoing decay and regenerating cycles across the entire continent. Images show evidence of gravity currents, trapped gravity waves, and mesoscale convective vortices associated with the dissipative stage of deep convection, which may explain the coherence of convection. The waves and vortices often greatly outlive the originating convective system and later induce new convection. The phase speeds of the precipitating convection episodes in central Africa were similar to those observed in other continental regions. The propagation leads to a delayed-phase shift in the diurnal maximum of convective precipitation over some regions. Episodes occur in the presence of moderate vertical shear of the horizontal wind. In central Africa, shear is associated with the migration of the African Easterly Jet and the Tropical Easterly Jet. The almost daily westward propagation of deep convection can be inhibited by changes in the large-scale circulation patterns, such as the passage of eastward moving equatorial waves or intrusion of lower tropospheric northwesterly winds. References Carbone, R.E., J.D. Tuttle, D. Ahijevych, S.B. Trier, 2002: Inferences of predictability associated with warm season precipitation episodes, J. Atmos. Sci., 59, 2033-2056.

Keywords: central africa, mesoscale convection, diurnal cycle

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JMS003 **Oral Presentation** **790**

Satellite observations of atmospheric methane by the Atmospheric Infrared Sounder (AIRS)

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Space-born observations of global atmospheric methane profiles can be achieved by using the Atmospheric Infrared Sounder (AIRS) on the EOS/Aqua platform. There are approximately 200 AIRS channels near the methane (CH_4) absorption band at 7.6 microns, and these channels are most sensitive to CH_4 in the middle to upper troposphere. More than three years of global CH_4 data (3 deg. x 3 deg.) from August 2003 to the present have been generated at NOAA/NESDIS/STAR. Validation using more than 600 aircraft-observed CH_4 profiles demonstrates that the rms errors of the retrieved profiles are about 1-1.5% depending upon the altitude. Analysis of these AIRS CH_4 data from August 2003 to present and some preliminary comparison with models will be presented. For example, in the high northern hemisphere AIRS CH_4 increases from June to August in the region which is mostly covered by the wetlands, and this increase is correlated with the increase of surface temperature in the summer. A CH_4 plume over the Tibetan Plateau is also observed in the afternoon for the first time as a strong enhancement of CH_4 in the upper troposphere up to 150 hpa in the summer, providing evidence of the deep convection over the Tibetan Plateau that transports air with rich CH_4 from the lower troposphere to the upper troposphere. High CH_4 mixing ratios associated with the rice emission from and its transport from to the Pacific Ocean with a maximum in August is evident too. This CH_4 product plus other trace gases, such as CO, CO_2 and O_3 will continue to be generated at NOAA/NESDIS/STAR as long as AIRS data are available. NOAA/NESDIS/STAR also plans to use other operational sounders like IASI and CrIS to derive atmospheric carbon over the next 20+ years to support the global change study.

Keywords: methane, airs, retrieval

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JMS003 **Oral Presentation** **791**

An Assessment of the CloudSat Data Products from the Canadian CloudSat/CALIPSO Validation Project

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On April 28, 2006 the CloudSat and CALIPSO satellites were launched from Vandenberg AFB in California. The goal is to obtain global measurements to better understand the role of clouds and aerosols in climate. The satellites joined the A-train constellation and are flying in close formation with Aqua. CloudSat, with its onboard W-band radar, and CALIPSO, with its dual-wavelength lidar, provide vertically resolved information that serves to compliment the observations by MODIS onboard Aqua. A comprehensive program to evaluate data products from CloudSat in cold season cloud systems over southern Canada was undertaken during the winter of 2006/07. The project involves under flights of CloudSat by a National Research Council of Canada Convair-580 research aircraft. The instrumentation on the aircraft includes a full suite of in-situ cloud, precipitation and aerosol sensors. Also on the aircraft are a W-band radar and a dual-wavelength lidar similar to that onboard the CloudSat and CALIPSO satellites. In addition, an enhanced measurement site at the Centre For Atmospheric Research Experiments (CARE) was operated in southern Canada to provide longer term measurements of clouds and precipitation. Instrumentation deployed at CARE included a lidar and radar system similar to those onboard the satellites, a profiling microwave radiometer, and a variety of in-situ precipitation sensing devices.The operational period for the validation was from late October, 2006, to early March, 2007. The flight strategy entailed flights beneath the satellite during overpasses in south central as well as dedicated flights over CARE. Twenty successful aircraft missions timed with the passage of CloudSat/CALIPSO have been flown. The cases have included examples of precipitation from synoptic snow systems, lake-enhanced snow squalls and rain with a low bright band. Non-precipitation systems sampled include multi-layer clouds, mixed phase clouds, cirrus clouds, liquid stratocumulus clouds, and aerosols layers. A direct comparison of the CloudSat data products with the airborne radar, lidar and in-situ measurements is underway. Statistical comparisons with the observations at CARE are also underway with an emphasis on precipitation products. The presentation will overview the data collection and presents some early results.

Keywords: cloudsat, a train

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JMS003 **Oral Presentation** **792**

Chemical characterization of the extratropical tropopause region using ACE satellite data

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The upper troposphere/lower stratosphere (UTLS) plays a key role in chemistry-climate coupling. Here, the radiative impact of ozone and water vapour is most effective in changing surface temperatures and hence climate. Climate change in turn has the potential through changing transport patterns and temperatures to sensitively alter the distributions of these and other tracers in the UTLS. Characterizing the chemical composition of the UTLS is challenging because of the small vertical and horizontal length scales involved. Most existing knowledge of the spatio-temporal structure of chemical composition in the UTLS, and its relation to dynamical features such as the tropopause, comes from aircraft and balloon platforms. On the other hand, these measurements are necessarily restricted in space and time. The Atmospheric Chemistry Experiment is a Fourier transform spectrometer (ACE-FTS) on board the Canadian SCISAT satellite offering unprecedented accuracy and vertical resolution, allowing a new global perspective on trace gas distributions in the UTLS. We examine vertical profiles of O3, CO, and H2O relative to local tropopause height and show by comparison with previous aircraft measurements in the Northern Hemisphere the high potential of the ACE measurements in resolving the vertical structure of UTLS tracer distributions. We then use the ACE measurements to derive the thickness of the extratropical transition layer i.e. the layer surrounding the extratropical tropopause which exhibits both tropospheric and stratospheric characteristics using different tracer-tracer correlations. The satellite measurements agree well with results from previous aircraft campaigns in the Northern Hemisphere and allow the extension of the evaluation to the Southern Hemisphere.

Keywords: utls, correlations, ace fts

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JMS003 **Oral Presentation** **793**

Geophysical validation of MIPAS-ENVISAT operational ozone data

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The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), onboard the ESA Environmental Satellite (ENVISAT), is a high resolution middle infrared Fourier transform spectrometer that performs atmospheric limb emission measurements for the retrieval of vertical profiles of temperature and of six target species (H2O, O3, CH4, HNO3, N2O and NO2).For the first two years of the mission the instrument operated at nominal spectral resolution and provided a full set of operational products with quasi-continuous and global coverage from March 2002 to July 2004.A comprehensive work for the geophysical validation of MIPAS-ENVISAT ozone profiles was conducted by using correlative data obtained from ground-based measurements (ozone sondes, lidar, microwave radiometers and Fourier transform infrared spectrometers), from remote-sensing and in-situ instruments onboard stratospheric aircraft and balloons and from concurrent satellite sensors (SAGE II, POAM III, ODIN-SMR, ACE, HALOE and GOME), as well as from ECMWF assimilated ozone fields.Here, we present the final outcome of this validation activity and our conclusions about the quality of MIPAS ozone operational products. By combining the results from a variety of validation experiments, we demonstrate the high quality of MIPAS ozone measurements in the stratosphere, with no significant bias and relative differences with respect to the correlative data always lower than 10% between approximately 25 km and 55 km. A degradation of the agreement between MIPAS and most of the coincident ozone profiles is observed outside this altitude range, both in the lower mesosphere and in the upper troposphere/lower stratosphere. This is evident, in particular, at the lowest altitudes, with the appearance of statistically significant biases from 5% to approximately 25% at ~15 km and standard deviation larger than the random error of the comparison by a factor of 1.5 to 3.0 in the range 15-25 km. Possible sources of these larger discrepancies are discussed and a final assessment on the validity of MIPAS ozone data (from ESA processor versions 4.61 and 4.62) for scientific use is presented.

Keywords: mipas envisat, ozone, validation

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JMS003 **Oral Presentation** **794**

Assessment of the Japan Sea variability with high resolution satellite data sets

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The Japan Sea (JS) is a large semi-enclosed oceanic basin located in subtropical and subpolar areas with monsoon climate characteristics and relatively limited exchange with surrounding ocean because of narrow and shallow straits. Variability of its surface temperature (SST) is controlled both by outer water inflow and by local atmospheric inputs and is characterized by quite a complex spatial and temporal pattern. In this study we used recently developed satellite data sets to analyze spatial and temporal characteristics of the JS SST variability. The study is based on New Generation SST (NGSST) daily data developed in Tohoku University by merging NOAA AVHRR infrared data, MODIS/Aqua and microwave AMSR-E/Aqua data. The set covers a period of 2002-2006 with spatial resolution 0.05x0.05. The other set we used is daily SST by Japan Meteorological Agency for western part of North Pacific, based on the set Merged satellite and in-situ data Global Daily Sea Surface Temperature (MGDSST). It is based on in-situ data collected by ships and buoys with addition of satellite data for recent years and covers a period of 1993-2006 with spatial resolution of 0.25x0.25. We have analyzed anomalies of SST derived from the principal components decomposition by the Complex Empirical Orthogonal Functions (CEOF). The time series for amplitude of temporal mode was examined using the wavelet analysis as contained non-stationary power at many different frequencies. As a result of decomposition the 1st mode of variability for the daily data describes 96% of overall variability for whole JS basin. This fact is considered as an influence of annual signal for highly auto-correlated daily data of SST. Hence we truncated from initial data variability connected with the 1st mode and analyze three subsequent ones which describe the maximum presence of variability. This allows us to examine annual, semi-annual and inter-annual components of SST variability. It was shown that in inter-annual scale most of oscillations of JS are standing one. The propagating anomalies are correspondent for intra-annual scale. The North-Western Branch of subpolar front divides JS on two parts with different kind of inter-annual variability. The subpolar front area showed semi-annual scale of variability for which is correspondent SST increasing in the May-June and October-November and decreasing in March and August-September. Spatial distribution for the NGSST and MGDSST taken with different and same time period showed similar results of decomposition. The CEOF decomposition for northern part of JS showed the own variability of the Northern Part of JS which is not seen if the whole basin scale of JS is considered. This part of JS also divided on two subparts with different kind of inter-annual variability and has own structure of annual, semi-annual and intra-annual variability.

Keywords: daily sst, japan sea, ceof decomposition

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JMS003 **Oral Presentation** **795**

Interannual variability of total ozone over the indian subcontinent: a study based on NIMBUS 7 TOMS data using Morlet Wavelet analysis

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Total ozone over the Indian subcontinent based on Nimbus-7 TOMS over pass data for the twelve Indian stations were analyzed using the advanced statistical method (Morlet wavelet analysis) to explore the major interannual variability present in the total ozone. We found two prominent oscillations present in the total ozone, one with a periodicity of 1618 months and the other with a QBO periodicity varying from 26 to 32 months. These oscillations were ound significant at above 95% level of confidence when we performed the power spectrum analysis

Keywords: ozone, inter annualvariability, obo

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JMS003 **Oral Presentation** **796**

MAIAC - Multi-Angle Implementation of Atmospheric Correction for MODIS

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A new Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm has been developed for processing of MODIS measurements. MAIAC is a generic algorithm which simultaneously retrieves the aerosol optical thicknessand surface bi-directional reflectance over landusing the 16-day time series of gridded MODIS L1B measurements. The new algorithm is generic and works globally over all surface types, including bright deserts, with the temporary exception of snow. MAIAC products include cloud mask, water vapor, aerosol optical thickness at 0.47 mm and 0.66 mm and Angstrom parameter, surface spectral bidirectional reflectance factor and albedo for the reflective land and ocean MODIS bands. All products are generated uniformly at 1 km resolution in gridded format. The initial comparison of the aerosol optical thickness with AERONET measurements for different types of aerosol, including urban/continental (USA, Europe), biomass burning (Africa, Brazil), dust (Saudi Arabia, China), shows a very good agreement.

Keywords: aerosol, atmospheric correction

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JMS003 **Oral Presentation** **797**

Status and Future of the Tropical Rainfall Measuring Mission (TRMM) after Nearly Ten Years

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The Tropical Rainfall Measuring Mission (TRMM) has successfully completed nearly ten years in orbit. A brief review of the history and accomplishments of this joint mission between the U.S. and Japan is presented. Research highlights will focus on application of TRMM data to topics ranging from climate analysis, through improving forecasts, to convection and storm research. Applications of TRMM data for tropical cyclone detection and analysis and for flood and agricultural monitoring will also be presented. These results will emphasize the breadth of science success achieved with the long record of observations from the only rain radar and passive microwave instrument combination in space. The status and future of TRMM operations and data products will also be described.

Keywords: satellite, trmm, precipitation

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JMS003 **Oral Presentation** **798**

Spatial and Temporal Distribution of Clouds as Observed by MODIS Onboard the Terra and Aqua Satellites

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The Moderate Resolution Imaging Spectroradiometer (MODIS) was developed by NASA and launched onboard the Terra spacecraft on December 18, 1999 and Aqua spacecraft on May 4, 2002. A comprehensive set of operational algorithms for the retrieval of cloud physical and optical properties (optical thickness, effective particle radius, water path, thermodynamic phase) have enabled over seven years of continuous observations of cloud properties from Terra and over five years from Aqua. The archived products from these algorithms include 1 km pixel-level (Level-2) and global gridded Level-3 products. The cloud products have applications in climate change studies, climate modeling, numerical weather prediction, as well as fundamental atmospheric research. Results include the latitudinal distribution of cloud optical and radiative properties for both liquid water and ice clouds, as well as latitudinal distributions of cloud top pressure and cloud top temperature. In addition to time series of cloud fraction, cloud optical properties, and cloud top properties, we will also present marginal probability density functions as well as joint probability density functions of cloud optical thickness, effective radius, and cloud top pressure for selected geographical locations around the world.

Keywords: terra, aqua, modis

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JMS003 **Oral Presentation** **799**

Satellite Observations of Tropospheric Composition: from Regional Air Pollution to Global Climate

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Satellite observations are revolutionizing atmospheric composition researchwith wide-ranging impact on topics ranging from mapping continental pollution outflow to top-down constraint on air pollutant sources/sinks. We present here several analyses of tropospheric composition data from TES,AIRS, MISR, andMODISusing chemistry transport models (CTMs) and in situ observations.The applications presented here range from characterizing regional air pollution to estimating global aerosol direct radiative effect. In the first application we examine the potential of usingTEStroposphericozone (O3) and carbon monoxide (CO)profiles to characterize Mexico City pollution outflow.TESO3 and CO data for March 2006 were compared with in situ aircraft observations from the INTEX-B/MILAGRO campaign and results from the GEOS-Chem global 3-D CTM.TES O3-CO correlation, particularly the slopeshows remarkable consistence with those derived from in situ observations andGEOS-Chem results. In the second application weinvestigate the large-scale atmospheric variabilities of carbon dioxide (CO2) andO3 in the upper troposphere as observed by AIRS. AIRS CO2 andO3 retrievals for 2003 using the VPD (vanishing partial derivative) technique[Chahine et al., 2005]areexamined. We interpret AIRS CO2 andO3 variabilities that are associated with underlying large-scale atmospheric transport usingthe Caltech/JPL 2-D CTMand GEOS-Chem as well as aircraft observations. Wefocus our analysis onthe spatial and latitudinal distributions of AIRS CO2,its seasonal cycle, and its correlation withO3 over deep convective regions such as south Asia in summer.In the third application we combineMISR andMODISaerosol, cloud, albedo, and surfaceproducts to estimatethe global (ocean and land) direct radiative effect of aerosols. The critical step is to estimate top of the atmosphere (TOA) albedo in the absence of aerosols.We derive aerosol-free TOAalbedo through regressions between MISR TOA albedo, aerosol optical depth (AOD), and BHRPAR (bi-hemispheric reflectance at photosynthetically active radiation wavelengths).A combination of MODIS cloud mask and MISR SVM (Support Vector Machine) scene classifiers are used for cloud filtering.

Keywords: satellite, pollution, climate

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JMS003 **Oral Presentation** **800**

Nowcasting severe convection using objective techniques that optimize the impact of sequences of GOES moisture products

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Future instruments (e.g., multi-channel geostationary imagers, hyperspectalsatellite sounders, Wind Profilers, automated aircraft reports, etc.) will resolve atmospheric features with resolutions far beyond todays capabilities in both time and space. Although these data are expected to improve NWP guidance at 48 hours and beyond, a greater benefit from these detailed time/space-frequency data (i.e., GOES) may come from objective nowcasting systems that assist forecasters in identifying rapidly developing, extreme weather events. Nowcasting systems must detect and retain extreme variations in the atmosphere (especially moisture fields) and incorporate large volumes of high-resolution asynoptic data, while also being extremely computationally efficient. This requires numerical approaches that are notably different from those used in numerical weather prediction, where the forecast objectives cover longer time periods. A new approach to objective nowcasting is presented that uses Lagrangian techniques (instead of Eulerian methods used in conventional NWP) to optimize the impact and retention of information provided by satellites. It is designed to detect and preserve intense vertical and horizontal variations observed in the various data fields observed over time which are often under-represented in conventional NWP systems. Analytical tests have confirmed this, as well as the computational advantages of this approach. Real data tests have been conducted with the goals of detecting the development of atmospheric details several hours prior the onset of significant weather events. Tests were made using multi-layer Derived Product Images (DPIs) of multi-layer moisture distribution obtained from current GOES sounders at full resolution (10 km) to update and enhance current operational RUC forecasts. The tests show that the Lagrangian system captures and retains details (maxima, minima and extreme gradients) critical to the development of convective instability due to differential transport of mesoscale moisture features several hours in advance, even for situations where subsequent satellite observations were no longer available due to cloud development. Results from case studies of hard-to-forecast isolated convective events show substantial skill in being able to define areas of convective destabilization not captured by convectional NWP systems 3-6 hours in advance using combinations of product images similar to those currently available for GOES derived product observations. These tests provide prototype examples of nowcast products that will be available at higher resolution using GOES-R ABI data. The technique can be applied to Meteosat data products as well. Initial assessments of these products within selected NWS WFOs will also be discussed.

Keywords: nowcasting, destabilization, moisture

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JMS003 **Oral Presentation** **801**

Evaluation of 1D models in the prediction of distributed flow series constrained by Radar altimetry data

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Recently, efforts have been done toward the development of methodologies to obtain flow estimates from time series of water height at virtual stations (VS intersections between satellite tracks and water surfaces) from Topex/Poseidon (TP) and ENVISAT radar mission measurements. Relatively simple 1D propagation models such as Muskingum-Cunge (M-C) Routing Model have presented good results in the water flow propagation in Amazonian rivers. These regions suffer, in most cases, of lack of information witch difficult more accurate hydrologic and hydraulic studies. However, these M-C models make a lot of simplification witch may cause the lost of important information that these quasi-ungaged basins can offer. This paper presents a comparison between two propagation models to the estimation of water flow series constrained by T/P and ENVISAT data. The models are: ProGUM, a Muskingum-Cunge flow routing model with diffusion-cum-dynamic wave propagation, and HEC-RAS, a well-known 1D hydrodynamic model. The verification was made in 28 reaches in the Negro River Basin. Each of these reaches are limited by two gauge stations, one upstream and the other one downstream. A total of 21 VS distributed over the reaches were analyzed. Previous studies have shown that ProGUM may yield errors less then 10% in validation phases. Here, it is demonstrated that, no much improvements can be achieved by using a more complete model capable to absorb the available data and simplifications of a M-C Model do not make significant modifications in the results of rating curve generation from satellite altimetry.

Keywords: altimetry, prediction, amazon

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JMS003 **Oral Presentation** **802**

World data center for remote sensing of the atmosphere (WDC-RSAT)

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Since 2003 the Applied Remote Sensing Cluster of the German Aerospace Center (DLR) has hosted and operated the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT, http://wdc.dlr.de) under the non-governmental auspices of the International Council of Science (ICSU). WDC-RSAT offers scientists and the general public free access to a continuously growing collection of satellite-based atmosphere-related data sets and services. These data holdings range from raw data collected by remote sensors, to information products derived from the raw data (value adding). The current WDC-RSAT data holding contains data and information products addressing atmospheric trace gases, clouds, surface parameters, solar radiation, and special services as near-real time (NRT) information related to e.g. European air quality, UV radiation forecasts, global ozone level maps. In addition to archiving data sets, WDC-RSAT cooperates with other data centers and strives to provide additional services, which includedata analysis and value adding, data summaries, campaign planning support, data set validation and publication. In support of its data provision activities WDC-RSAT utilizes decentralized on-line robot-driven technology with a storage capacity of more than 300 Tbytes, as well as electronic interfaces (EOWeb, interoperable catalogues, interactive post-processing and processing on demand). In Germany, three current ICSU World Data Centers, namely WDC-Climate (hosted by the German Climate Computer Center, DKRZ), WDC-MARE (co-hosted by the Alfred Wegener Institute for Polar andMarine Research(AWI) and the University of Bremen), WDC-RSAT (hosted by DLR), and the pending WDC-Terra (to be hosted by GeoForschungsZentrum Potsdam) founded in 2004 the German WDC cluster for Earth System Research, in order to promote Earth System Science and Research in Germany and abroad. This Cluster is actively pursuing a strategy, using information technology, to make data related to Earth Systems available to an as wide and as interdisciplinary possible audience. In early 2006 a scientific advisory committee for WDC-RSAT was established. External experts representing space agencies, weather services, atmospheric remote sensing technologies, and atmospheric science help to guide WDC-RSAT in setting and reaching its goals. In cooperation with the World Meteorological Organization (WMO), WDC-RSAT is aiming to become part of a data integration center to be created within the WMO program Global Atmospheric Watch (GAW). This center would concern itself with linking different GAW-relevant data sets both with each other and with models. In this context WDC-RSAT will also handle non-satellite based data which is relevant within the context of validation.

Keywords: world data center, remote sensing, atmosphere

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JMS003 **Oral Presentation** **803**

Towards air/sea CO2 fluxes from space

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One of the large unknowns in the global CO2 budget is the flux between the ocean and the atmosphere. In this paper we report some of the results from the CASIX programme in the UK. The CO2 flux can be represented as the product of the gas transfer coefficient, the solubility of CO2 and the difference in the partial pressure of CO2 (pCO2) between the atmosphere and ocean. The solubility is known to depend mainly on the sea surface temperature, which we already measure from space. We are developing new climatologies of both the transfer velocity and the oceanic pCO2. The gas transfer velocity climatology is based on a new formulation due to Woolf and Fangohr. This depends not only upon wind speed but also on the wave height. We can measure both of these parameters from a radar altimeter. We present maps of transfer velocity from year to year and look at how it changes with climate indices such as ENSO and the NAO. Estimating the oceanic pCO2 from space is more difficult. We present initial results relating in situ pCO2 measurements to variables that we can measure from space such as sea surface temperature and ocean colour.

Keywords: air sea flux, co2

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JMS003 **Oral Presentation** **804**

Measurement of Air Quality and Climate Gases from Space

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SCIAMACHY measures the back-scattered radiation upwelling from the top of the atmosphere in a variety of viewing geometries from 214 to 2380 nm. Inversion of the nadir measurements yields the amounts and distributions of key tropospheric gases both the short lived gases impacting on pollution and oxidative capacity such as nitrogen dioxide, NO2, Sulphur Dioxide, SO2, Formaldehyde, HCHO, Glyoxal, CHO.CHO and Carbon Monoxide, CO and the long lived greenhouse gases carbon dioxide, CO2 and methane, CH4. This talk will focus on the results obtained in the first five years and the importance of the results for atmospheric pollutants and the fluxes of greenhouse gases.

Keywords: pollution, climate

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JMS003 **Oral Presentation** **805**

Physical, statistical and temporal analysis approach for MSG cloud identification

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The cloud detection from remote sensing data is required for many applications; many current algorithms for the retrieval of geophysical and atmospheric parameter such as temperature and humidity profiles are developed for clear data. A physical and statistical approach have been developed for MSG-SEVIRI (Meteosat Second Generation - Spinning Enhanced Visible and Infrared Imager) data and their results have been combined in order to improve cloud identification. The statistical algorithm is a pattern recognition technique that uses textural and spectral features estimated in boxes 3x3. The spectral features used in this analysis are the grey level maxima, minima, mean and the ratio between maxima and minima. The textural features include the contrast, the entropy, the mean, the angular second moment in four directions and the Robert Gradient. The algorithm has been trained on the basis of MSG data collected in different seasons, in different area and at different times, in order to get a significant database. The physical approach is based on dynamic threshold tests and it does not require any ancillary data. The two algorithms run independently and the final results are processed in order to decide the final FOV flag. The final algorithm, the MACSP (Cloud MAsk Coupling of Statistical and Physical method), has been validated against the MODIS cloud mask and compared with the SAFNWC cloud mask. The FOVs detected in the same way by the MODIS and the MACSP cloud mask represent the 93% of the total number of MSG-SEVIRI FOVs used for validation, whereas the SAFNWC cloud mask detects correctly the 91% of the same FOVs. In particular the MACSP classifies as cloudy the 9.1% of the FOVs classified as clear by the MODIS cloud mask, while the SAFNWC cloud mask classifies as cloudy the 12.3% of them.Moreover, a temporal analysis has been applied to a set of subsequent MSG-SEVIRI images in order to verify some FOVs declared as uncertain by the MODIS cloud mask algorithm. The temporal analysis is based on a pattern recognition technique and its results are useful in classifying the MODIS uncertain FOVs correctly, particularly the FOVs classified as uncertain by the test onTb(3.9)-Tb(10.8) brightness temperature difference.

Keywords: cloud, detection, seviri

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JMS003 **Oral Presentation** **806**

The latest development of the NASA/GEWEX SRB Project: Overview and Analysis of A 22-Year Global Solar and Terrestrial Radiation Dataset

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IAMAS Satellite Observations: Products and Applications IAMAS

Paul W. Stackhouse, Jr., Shashi K. Gupta, Stephen J. Cox, J. Colleen, Mikovitz, Laura M. Hinkelman

The NASA/GEWEX (Global Energy and Water cycle Experiment) SRB (Surface Radiation Budget) project is an important one under the backdrop of a variety of issues concerning global climate change, environment and energy. The objectives of the project include producing quality shortwave/longwave radiation data for the climate community, furthering the understanding of the role of energy and water cycle as feedbacks of the climate system, improving the predictive capability for weather and climate, and undertaking joint projects and services to demonstrate the value of the GEWEX project in assessing the change and consequences of the global climate change. The SRB project has produced in its latest Version 2.5 (2.9 for shortwave) estimates of surface and top of the atmosphere (TOA) shortwave and longwave fluxes at a 1 degree by 1 degree resolution from July, 1983 to June, 2005. Satellite and assimilation products are the inputs of the project. The Goddard Earth Observing System V 4.0.3 (GEOS-4) long-term meteorological assimilation data provide the water vapor and temperature profiles. The International Satellite Cloud Climatology Project Pixel-Level (ISCCP-DX) data are used to derive the surface and cloud radiances and cloud retrievals. Column ozone values are produced by filling gaps in (Total Ozone Mapping Spectrometer) TOMS with data from the Television and Infrared Observation Satellite (TIROS) Operational Vertical Sounder (TOVS) archive. The flux data are computed from primary and secondary algorithms that treat atmospheric and surface properties on the first physical principles and use parameterization when necessary. The TOA fluxes from the primary algorithm is a major contributor to the GEWEX Radiative Flux Assessment (RFA) activity. The data is validated against data from the Baseline Surface Radiation Network (BSRN), the World Radiation Data Center (WRDC), the Global Energy Balance Archive (GEBA), the Atmospheric Radiation Measurement (ARM) networks, and the National Solar Radiation Data Base (NSRDB), and very good agreement is achieved. For instance, the monthly mean bias and RMS errors against the 3490 site-months of BSRN data, the ground truth considered the best quality so far, are -7.28 and 23.28 watts per square meter for surface shortwave downward flux, and -1.51 and 13.17 watts per square meter for surface longwave downward flux. It is especially encouraging that the SRB data show consistently good agreement with several BSRN sites with long-term records since 1992. Effort is being made for further improvement. The SRB data are also compared with the ISCCP Flux Data (ISCCP-FD), Clouds and the Earth's Radiant Energy System (CERES), Forty-Year European Re-Analysis (ERA-40) and National Centers for Environmental Prediction (NCEP). We examine the seasonal and interannual variabilities of the radiation fluxes and cloud forcing globally as well as zonally. Both surface and TOA fluxes are compared with datasets such as ISCCP-FD in terms of magnitudes, temporal and spatial variabilities. We also investigate how signals of global and regional climate variations, such as El Nino Southern Oscillations and North Atlantic Oscillations, manifest in the SRB data, and empirical orthogonal function (EOF) analysis and canonical correlation analysis (CCA) have been conducted. It is found that the correlation coefficient between the first EOF coefficient of the surface shortwave downward flux over the Pacific region and the Souther Oscillation Index is as high as 0.70.

Keywords: satellite, radiation, gewex

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JMS003 **Oral Presentation** **807**

The Impact of the Adelie Land Katabatic Wind Regime on Coastal Cyclogenesis

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The most intense katabatic wind regime in Antarctica is located along the coast of Adélie Land, where the annual mean wind speed recorded at Cape Denison in 1912-13 by Douglas Mawsons Australasian Antarctic Expedition was 19.4 m s-1. Both observational and model-based studies have identified the off-shore region of the George V Coast (near 150E) to be a region of cyclogenesis, although few studies have provided a physical explanation as to why cyclogenesis occurs there. Extensive research of mesoscale cyclone activity in the Ross Sea region has identified katabatic winds as a key component of cyclogenesis events. For the Adélie Coast region it is inferred that off-shore katabatic winds aid in establishing a low-level baroclinic zone favorable for cyclone development, as cold drainage flow from the inland plateau is advected into the coastal maritime environment. Cyclogenesis would be expected to occur on the cyclonic shear side of the katabatic jet (to the east) as the katabatic jet interacts with the ambient synoptic-scale flow. In this study the results from the manual tracking of cyclonic features from two years of high-resolution MODIS infrared imagery are analyzed to determine the level of cyclogenesis, cyclolysis, and overall cyclone activity in the Adélie Coast region. Climatological fields from the 1979-2002 ERA-40 reanalysis are used to determine the synoptic setting of cyclogenesis events. Output from the Antarctic Mesoscale Prediction System (AMPS) is used to determine the role of katabatic winds and other mechanisms in coastal cyclogenesis for case study events. Besides determining the physical mechanisms responsible for cyclogenesis, the results provide the best climatology of cyclone activity for the Adélie Coast region to date.

Keywords: modis, cyclogenesis, katabatic

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JMS003 **Oral Presentation** **808**

Toward applications of NASA'S satellite and modeling data in the energy, architecture and agriculture sectors: THE POWER Project of NASA

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IAMAS Satellite Observations: Products and Applications IAMAS

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NASA has a long history of launching and maintaining satellites of various types for the purpose of studying weather and climate on a global scale, and over the years, valuable data about the Earth system on the order of terabytes have been derived from observations made by instruments onboard these satellites. In the course of time, it was realized that these satellite data are not only in the interest of pure academic research, but have tremendous potential for practical applications in various societal sectors, especially the energy, architecture and agriculture sectors. But the philosophy and methodology behind the scholastic tradition of science have rendered the data nearly inaccessible to the sensibility of the broad engineers, architects and agriculturists. It was under such a circumstance that the Prediction of the Worldwide Energy Resources (POWER) Project was initiated under the NASA Science Mission Directorate Applied Science Energy Management Program. Through this project, we tailor and reorganize our satellite and modeling data in the terminology of users and provide the parameters they actually need. NASA supports World Climate Research Programme (WCRP)/Global Energy and Water cycle Experiment (GEWEX) scientific projects such as the International Satellite Cloud Climatology Project (ISCCP), the Surface Radiation Budget (SRB) project, and the Global Precipitation Climatology Project (GPCP) which produce data products and necessary parameters for these applications. Other meteorological data from NASA's Global Modeling and Assimilation Office (GMAO) data sets are also used. These data are provided through NASA's Surface meteorology and Solar Energy (SSE) website (http://eosweb.larc.nasa.gov/sse/ and http://power.larc.nasa.gov). The POWER project is in partnership with the National Renewable Energy Laboratory (NREL) of the Department of Energy (DOE) and the Natural Resources Canada (NRCan) organization of the Canadian government. The current Version 5.1 SSE data provide over 200 parameters over the globe at a 1 degree by 1 degree resolution for a period of over 22 years starting from July, 1983, and the time span continues to expand. Since inception, the web site has now had over 5 million hits and 1 million data document downloads. The renewable energy sector, particularly solar energy sector, has used the various cloud and solar radiation parameters available. The SSE web site is directly linked to two decision support tools to expand the ability of these tools to optimize and integrate renewable energy systems anywhere in the world. The building engineering/architecture sector requires the direct normal radiation and diffuse radiation on various time scales in order to better optimize building orientation, passive and active solar heating devices, and the size of heating, ventilation, air-conditioning, and refrigeration systems. A new buildings prototype has been developed to test delivery of parameters tailored to the data requirements of this sector. The agriculture sector is concerned with total downward solar radiation, photosynthetically active radiation (PAR), dew point temperature, precipitation, maximum and minimum temperatures in addition to other climatological data. Another agroclimatology prototype has been developed to test delivery of data sets to this sector. Meanwhile, NASA is developing capabilities through the POWER project to produce near real-time data via the NASA Fast Longwave and SHortwave radiative Fluxes (FLASHFlux) project providing nearly the identical sets of parameters within a week of observation. In this presentation, we review the latest development of the POWER project.

Keywords: satellite, radiation, energy

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JMS003 **Oral Presentation** **809**

Assimilation of TES observations for the analysis of processes governing the composition of the troposphere

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Differences in tropospheric ozone (O3) and carbon monoxide (CO) from two global models of tropospheric chemistry and transport are examined through assimilation of observations of O3 and CO from the Tropospheric Emission Spectrometer (TES). The TES data for August 2006 are assimilated, using a suboptimal Kalman filter, into the GEOS-Chem model and into a version of the NOAA GFDL AM2 general circulation model with full tropospheric chemistry and with dynamics nudged toward NCEP reanalyses. The assimilation of the TES data significantly reduces the regional differences in the O3 distribution in the two models. Over North America, for example, the bias in O3 between the models is reduced from 11 ppb to 2 ppb in the middle troposphere. Examination of the O3 analyses suggest that the differences in the representation of the source of NOx from lightning is an important contribution to the discrepancies in O3 in the models.

Keywords: troposphere, ozone, assimilation

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JMS003 **Oral Presentation** **810**

Multi-disciplinary applications of the Gravity Recovery And Climate Experiment (GRACE)

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The twin satellites of the joint NASA/DLR mission GRACE were launched on March 17, 2002. The purpose of the GRACE mission is to measure the time-variability and long-term mean mass distribution within the Earth system. For the last five years, GRACE has continued to provide measurements of mass flux between the land, ocean, atmosphere and the cryosphere with un-precedented detail and accuracy. In this paper, we will survey the state of the multi-disciplinary science applications of the GRACE mission, being developed independently, and in conjunction with various satellite (TOPEX/Poseidon, Jason-1, ICESat) and in-situ data. Some relevant topics where rapid progress has been made recently include the determination of water storage changes in ever-smaller river basins; the extraction of evapo-transpiration across the land-atmosphere boudary, which is of significance for atmospheric models; and the variations in the global ice-sheets and their contributions to sea-level. Over the oceans, we will discuss the contributions to the determination of the ocean currents and their time-variability, as well as its contributions to the separation of the steric and mass variations in the global mean sea level. We will conclude with remarks on the ongoing GRACE mission plans, and outlook for the future.

Keywords: grace, water cycle, climate variability

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JMS003 **Oral Presentation** **811**

Validation of ACE NOy Measurements

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The accuracy and reliability of the measurements from the Atmospheric Chemistry Experiment (ACE) satellite mission are validated by comparing them to a series of measurements made by satellite-, balloon- and ground-based instruments. Launched on 12 August 2003, the ACE satellite (SCISAT-1) is in an 74o orbit at 650 km altitude. ACE science operations began in February 2004. Two instruments on board the satellite provide measurements of chemical species: a high-resolution infrared Fourier Transform Spectrometer (ACE-FTS) and a dual UV-visible-NIR spectrophotometer called ACE-MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation). The primary goal of the ACE mission is to provide measurements to increase our understanding of the ozone distribution in the upper troposphere and the stratosphere, especially over the Arctic. Both vertical profile and column measurements are being used as part of the validation of NO, NO2, ClONO2, HNO3, N2O5 and N2O from ACE-FTS version 2.2 and NO2 from MAESTRO version 1.2. In this presentation, Ace vertical profiles will be compared with measurements by balloon-borne and other satellite instruments. In addition, ACE measurements will be compared with ground-based measurements by Fourier transform spectrometers (which provide total or partial columns of NO, NO2, ClONO2, HNO3 and N2O) and with UV-visible grating spectrometers (which give NO2 total columns, and in some cases, low-resolution NO2 profiles).

Keywords: ace, validation, noy

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JMS003 **Oral Presentation** **812**

Interannual variability of North Brazil Current Rings derived from satellite altimetry

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The North Brazil Current retroflection regularly sheds large anticyclonic rings that propagate northwestward along the coast of South America between about 8 N and the Caribbean Sea. These anticyclones are known to be an important pathway of the warm northward return flow of the Atlantic thermohaline circulation. Therefore, understanding the interannual variability of these rings may help to better understand the Atlantic inter-hemispheric water exchange. North Brazil Current rings have a strong (~1 m/s) shallow velocity structure and associated sea surface height signature that can be systematically tracked by satellite altimetry. The rings were tracked by fitting a Gaussian model to the sea surface anomaly from TOPEX/JASON-1 alongtrack data in the region. To characterize the rings, the amplitude (maximum surface elevation) and size (radius of maximum swirl velocity) are estimated for each ring from the adjusted coefficients of the fits. Using the gradient momentum balance to approximate the ring dynamics, velocities and sea surface height anomaly can be related to each other. Two rings sampled by altimetry and simultaneous shipboard Acoustic Doppler Current Profiler (ADCP) surveys showed close agreement in ring parameters, and therefore validate the altimetric technique. Thirteen years of TOPEX/JASON-1 data are used to generate a climatology of the rings. Rings show a large range of SSH amplitudes and sizes, with amplitudes spanning a range of 10-25 cm (with a mean of about 16 cm) and radii of maximum velocity from 60-180 km (with a mean of 130 km). The overall dimensions of the rings are much larger, typically 300-400 km. The analysis shows that many of the rings are close to the maximum strength of anticyclones permissible at these latitudes. Interannual variability of ring intensity and formation rate using the validated methodology will be described. Preliminary analysis suggests that an increase in ring intensity, both in average amplitude and size, occurred around 2000-2001, which could be related to an increase in the intergyre flux by the rings after this period.

Keywords: altimetry, rings, interannual variability

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JMS003 **Oral Presentation** **813**

Evolution of the Kuroshio large meander detected by satellite altimeters

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The sea-surface velocity evolution of the Kuroshio large meander during 2004 2005 was detected by using satellite altimetry and drifting-buoys data. Previous studies which were mainly based on field observation data had difficulty to research wide area because of their insufficient spatial coverage. Although sea-surface geostrophic current can be provided continuously widely by satellite altimeter, it is limited to anomaly component. Uchida and Imawaki (2003; Geophys. Res. Lett. 30 (5), 1229) developed a method where the missing mean velocity is estimated by combining in situ velocities estimated from trajectories of surface drifting-buoys with velocity anomalies derived from altimeter data. By adding the estimated mean velocity to those velocity anomalies, we can provide a time series of absolute velocity field. The Kuroshio took the large meander path for about 9 months after the summer of 2004, and the large meander has been the first since observation of the satellite altimeter TOPEX/POSEIDON started in 1992. In this study, we examined the evolution of the velocity field and the Kuroshio path during the transition from the non-large meander to the large meander of the Kuroshio. The surface velocity field during 1993 to 2005, including the whole period of evolution of the Kuroshio large meander in 2004, was estimated by the method of Uchida and Imawaki (2003). Then the position of the Kuroshio axis was detected by using the method developed by Ambe et al. (2004; J. Oceanogr. 60, 375-382) to investigate the conditions for the evolution of the Kuroshio meander quantitatively. It is known that a small meander (called a trigger meander) southeast of Kyushu, Japan develops eastward, and finally the Kuroshio shifts to the large meander. In the case of 2004, this trigger meander appeared in February 2004, having a relatively lager scale than usual. This meander developed to Kii Peninsula with keeping the large amplitude, and in July, the Kuroshio meander trough shifted to the south of Kii Peninsula. Just before the shift to the large meander, the Kuroshio axis took the most southern position during the entire period of non-large meander; at that time, the Kuroshio run over the Koshu Sea-mount south of Kii Peninsula. After that, the Kuroshio flowed over this sea-mount until taking typical large meander path in October 2004. This result is consistent with the result of numerical study indicated by Endoh and Hibiya (2001; J. Geophys. Res. 106, C11, 26,833-26,850). The Kuroshio took the typical large meander path stably until spring of 2005. When the Kuroshio shifted to the non-large meander from March to June in 2005, the axis position was unstable over Izu Ridge with approaching cyclonic eddy from east, while the axis shifted straightforwardly to nearshore side off Kii Peninsula.

Keywords: kuroshio, large meander, satellite altimetry

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JMS003 **Oral Presentation** **814**

Algorithmic and trade-off study for the Generation of a GOCE User Toolbox

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A strong impact is expected from GOCE Mission, in conjunction with altimetric missions, to access for the first time to the absolute ocean dynamic topography and consequently to the absolute ocean circulation at spatial scales down to 100 km. Currently, only the variable part of the sea level can be deduced from altimetric heights at an accuracy compatible with ocean circulation studies. The GOCE mission is therefore of the greatest interest for the oceanographic community. However, no ocean circulation products are planned to be delivered as level-2 products as part of the GOCE project so that a strong need exists, for oceanographers, to further process the GOCE level-2 geoid and merge it with Radar Altimetry. This need, and subsequent recommendations for an optimal use of GOCE data by oceanographers, have been explicitly expressed during the second International GOCE Workshop which was held in ESRIN from 8-10 March 2004. In order to facilitate the use of GOCE products for oceanographers and other commnuitites such as Solid Earth physicists and answer to particular needs of specific applications, the development of a user toolbox was clearly recommended. The aim is to facilitate the using, viewing and post-processing of GOCE Level 2 mission data products in conjunction with radar altimetry from ERS and ENVISAT, for an optimal use by oceanographers and solid Earth physicists at higher levels and the handling of necessary auxiliary data. For oceanographers, such a tool, and its tutorial alongside, would be a basis for the computation and validation of an ocean absolute dynamic topography and, indirectly, for the validation of Level-2 products. ESA has conducted an algorithmic and trade-off study, coined GOCE User Toolbox Specification (GUTS), in preparation for the development of an open source GOCE User Toolbox in a subsequent phase. The Toolbox will, among other functionality, produce an ocean absolute dynamic topography using GOCE level 2 product, a geoid, and radar altimetry from ERS and ENVISAT. The study has produced an algorithms specification and an architecture design to be used for the phase 2, the subsequent development of the GOCE User Toolbox. This paper will report the achievement of this study and show what the group of scientists involved in this study has recommended for a first version of the GOCE user Toolbox.

Keywords: goce, toolbox

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JMS003 **Oral Presentation** **815**

Three years of MAESTRO operation on the ACE satellite

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Environment Canada Atmospheric Science and Technology

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The Canadian Atmospheric Chemistry Experiment (ACE) was launched in August, 2003. This satellite carries two atmospheric, solar occultation instruments on board: a Fourier Transform Spectrometer (ACE-FTS) and a photo-diode array spectrometer called MAESTRO - Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation. More than 3 years of data have now been collected and several validation exercises have been completed. The MAESTRO instrument and its analysis algorithms will be briefly described and results from data comparisons presented which demonstrate the performance of the instrument and provide information about the usefulness of the data products.

Keywords: mcelroy, spectroscopy, occultation

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JMS003 **Oral Presentation** **816**

Detection of the larix decidua phenological cycle in the alpine environment by using MODIS data

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In this contribute we present the preliminary results of the REPHLEX Project (REmote sensing of PHenology Larix Experiment). The objectives of this project is to study the interannual variability of the phenological cycle of Larch (Larix decidua) in the Alpine region of Aosta Valley (Northern Italy) in relation to recent climatic variations. The Larch phenological cycle was analysed by combining field observations, models of phenology and satellite remote sensing. Ground observations and field measurements were collected in 8 test sites during 2005 and 2006 in order to determine the budburst, senescence and length of growing season (GSL). Moreover, in each site it was measured leaf area index by hemispherical photographs, chlorophyll fluorescence and structural parameters. Two different models of phenology were used: a Spring Warming model (SW) for the estimation of the dates of budburst and the Growing Season Index model (GSI) for the estimation of GSL. The calibration of the models was performed by means of their numerical inversion against data collected in 2005, in order to determine the uncertain parameters. Models parameterization was then validated against data collected in 2006. The results of SW model show a good agreement of the modelled budburst with the observed data (RMSE=4 days). GSI model gives the prediction of the beginning and the end of growing season with mean errors of 7.51 and 9.83 days, respectively. The derived growing season length is described with accuracy (RMSE = 5.83 days). This work has demonstrated that the GSI model, originally developed for applications at global scale, can be used in alpine environment in monospecific studies focused at a local scale. MODIS 250 16-days composite NDVI data (Product MOD13Q1) acquired from TERRA platform for the 2000-2005 time period were downloaded from the EOS data gateway. The extraction of budburst and senescence dates were conducted by exploiting different methods based on the NDVI time series analysis. Best results (EF=0.6; RMSE=5.2 days) were achieved by fixing an NDVI threshold that identify budburst and senescence defined using the data collected during the field campaign (NDVI > 0.63 budburst; NDVI < 0.62 senescence). This method was applied for the extraction of the phenological parameters for the time period 2000-2005 in order to evaluate the interannual variability. In summary, the preliminary results show that modelling and remotely sensed data are useful for the analysis of the phenological cycle of Larch. Meteorological driven models provide encouraging results at local scale, nevertheless their application at regional scale can be compromised by lack of detailed meteorological surfaces. In contrast remote sensing may provide important information also over morphologically complex regions as the Alpine area. The analysis of the interannual variability shows different responses of the vegetation as a function of elevation and climatic conditions. It was observed a divergent response during the 2003 heat wave between sites positioned at high and low elevation: there are evidences of an earlier senescence for sites at low elevation and a delay for those at high elevation.

Keywords: phenology, climate change, alpine environment

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JMS003 **Oral Presentation** **817**

Danube Flood Mapping at two flood plains of Romania using Multi-sensors: ERS2-SAR & Landsat-TM5

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In recent decades, increasing frequency and severity of hydrologic extremes such as floods have been on the rise globally. Partly due to the general high density of urban population, and partly some parts of some European cities are built on flood plains, about a 10th of Europeans live or work on flood plains. Between 1971 and 1995, 154 major floods occurred in Europe. Therefore this study is to explore using the multi-sensor technique of mapping flood plains of the Danube River Basin located at the lower zones of Romania-Serbia borders using ERS-2 SAR (Synthetic Aperture Radar) and Landsat-TM5 data during the April-May, 2006 period. Several mapping techniques are compared: (1) A change detection technique by subtracting pixel values of an image acquired during flooding from that acquired during dry condition, (2) Do a principal component analysis (PCA) on multi-temporal satellite images, and the first few PCs identified should either represent permanent water bodies, flooded areas, or dry lands, and (3) The idea of first transforming the data by a Morlet wavelet to test if more precise flood zones can be more precisely delineated wavelet transformed data was also attempted. The flooded areas so retrieved were assessed with respect to a set of high resolution DEM data and site information.

Keywords: danube flood mapping, ers2 sar and landsat tm5

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JMS003 **Poster presentation** **818**

Trend terms in tropopause and stratopause height time series at low latitude from HALOE

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UAR (Upper Atmosphere Research) satellite has been measuring various parameters since its launch in 1991. We have used its temperature data for the period 1991-2005 to examine the trend of tropopause height (TPH) and stratopause height (SPH) at low latitude (23oN, 75oE). Multiple linear regression (MLR) techniques have been used for the analysis of the quasibiennial oscillation (QBO), seasonal, interannual and solar cycle terms. Considering the whole period of data we find that mean tropopause height is 17.222 km and mean stratopause height is 47.550 km. We also find that for tropopause height the value of coefficent of linear trend term is positive indicating thereby that tropopause is going up over the years. While the value of coefficent of linear trend term is negative for stratopause height, indicating that stratopause is going down over the years. After applying the above corrections, some wave like variation is still seen in the time series.

Keywords: tropopause, stratopause

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JMS003 **Poster presentation** **819**

Correlation between surface reflectance at mid-infrared and visible channels obtained with MODIS near Aeronet sites in Brazil

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Aerosols are suspended particles that scatter and absorb solar radiation and have impact on climate. Therefore, measuring the aerosol optical and physical properties is very important. Operational remote sensing from satellites is a tool to optically characterize aerosols globally. The Moderate Resolution Imaging Spectroradiometer (MODIS) is an advanced sensor developed by NASA with 36 spectral channels ranging from 0.41 to 15 µm. This sensor aboard TERRA and AQUA satellites has the capability of observe nearly the entire earth every two days. The algorithm for retrieving aerosol optical thickness over land from MODIS assumes that a good correlation between surface reflectance at 2.1 µm and surface reflectance at visible channels exists. These important correlations are used to eliminate the contribution of surface in the signal received by the sensor at visible channels. A correct estimation of this contribution is a challenge and is important to a good determination of aerosol properties over land by satellite. However, recent works suggest that the correlations are angle and surface type dependent and need improvements. This paper shows results for correlations between surface corrected reflectance at 2.1 µm and surface corrected reflectance at visible channels (0.47 and 0.66 µm), with data obtained from MODIS at pixels situated near AERONET sites in Brazil as So Paulo and Alta Floresta. AERONET data are necessary to perform atmospheric corrections on MODIS data with the help of a radiative transfer code. The obtained results show dependence with the scattering angle between the Sun and the sensor, in accordance with previous studies.

Keywords: aerosols, remote sensing, surface reflectance

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JMS003 **Poster presentation** **820**

Study over the Southern Hemisphere using GPS, ECMWF reanalisys and radiosonde data

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Profiles derived from the GPS occultation experiment on board the CHAMP and SAC-C satellites were analysed and compared with data from nearby radiosondes and monthly means ERA40 reanalysis over the Southern Hemisphere(SH). Seeing that the tropopause is a key feature of atmospheric structure and an overall understanding of stratosphere-troposphere exchange is dependent on an ability to quantify its behaviour and variability, the present work has the purpose to seek an improved characterization of atmospheric structure associated with the presence of single and double tropopauses, defined using the lapse rate tropopause (LRT) definition. Several parameters for the significant levels in the satellite data- such as temperature, height and pressure- were studied for events located in the SH latitudes for years between 2001 and 2003. The Hemisphere in study was divided in three bands from the Equator to the South Pole, thirty degrees each of one (low, medium, high latitudes). The observations derived from GPS and also from radiosonde are nearly dense enough over land, but are decreasing from low to high latitude, and are even less considered stations over the sea. Statistical comparison of the profiles obtained by CHAMP and SAC-C with radiosonde measurements and monthly means values from reanalysis indicates a very good agreement at altitudes below the tropopause levels, specially between radiosonde and GPS, where the temperature bias is less or equal to 2 K. These biases increase with altitude, especially at the tropopause level and above , where the differences between the data of the three methods can reach 6 K or even some degrees more at the low stratosphere. Data from reanalysis always present more significant differences with the other two methods. The key of this research is to point out that the location of the tropopause levels present in most case a overestimation for the temperatures profiles derived from GPS when compared with radiosonde ones,which relapse on pressure and height values. On the other hand, monthly means values from reanalysis present a underestimatio at tropopause level, while in the upper levels the biases increases compared with GPS and radiosonde data. Moreover, considering the LRT definition, is possible to obtain from radiosonde data the location not only for single tropopause, but also multiple tropopause. Ragarding this point, height, temperatue and pressure can be obtained por multiple tropopause events mainly for medium and high latitudes. Although for this two bands,the tropopause from GPS retrievals can merely be detected, and when this occur, there is present a single one in most of the cases.

Keywords: lapse rate tropopause, comparison, southern hemisphere

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JMS003 **Poster presentation** **821**

Precise orbit determination of GPS by regional data

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PANDA (Position And Navigation Data Analysis) software developed on Wuhan University ,is introduced for the first time in this paper, then the precise orbit determination of GPS satellites and predicted orbit based on the data of 7 stations in China region is obtained by PANDA software . The comparison between the precision Ephemerides that provided by IGS, shows that both of the accuracies level. In the end, the meaning of the orbit determination by regional data will be introducted.

Keywords: panda, precision orbit determination, gional data

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JMS003 **Poster presentation** **822**

Satellite observations of thermal variability in the Western Pacific Warm Pool

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The thermal variability of the western Pacific warm pool (WPWP) have been investigated by using the Advanced Very High Resolution Radiometer (AVHRR) data onboard the National Oceanic and Atmospheric Administration (NOAA) series satellites from 1982 to 2005 and TOPEX/Poseidon (T/P) and Jason-1 satellite altimeter data from 1992 to 2005. The WPWP is defined as the area where the sea surface temperature (SST) is higher than 28 C. The thermal trend and individual period components are then analyzed by the Empirical Mode Decomposition (EMD) method. Results show that the SST and size of WPWP increase during the data period. The temporal cycles of semi-annual, annual, 3-year, 7-year and 10-year are the main components to affect the thermal variation of WPWP. The components of 3~7 years which are related to ENSO phenomenon basically determine the variation of WPWP. Besides, the mean rise rate of SST increases slowly from 1982 to 1988 (0.036 C/decade), but rapidly increases from 1989 to 2005 (0.168 C/decade). The mean rise rate from 1982 to 2005 is 0.144 C/decade which is higher than the global mean value at 0.09C/decade. The area of WPWP increases by 1.92x10^6 km^2/decade from 1982 to 2005 as well. The variation of WPWP size and SST exhibits the surface thermal variability of WPWP. In order to analyze the upper thermal structure of WPWP, we estimate the heat storage anomaly (HSA) from T/P and Jason-1 altimeter data. The HSA inferred from altimeter data agrees well with the estimation from measurements of Tropical Atmosphere Ocean (TAO) buoys with a correlation coefficient of 0.9. The time series of HSA shows a warming before the onset of the 1997-1998 El Nio and then a rapid cooling during the El Nio period. The upper oceanic warming rate is 1.38 W/m^2 from 1992 to 2005, which is higher than the global mean value at 0.86 W/m^2. The pattern of heat storage rate is associated with the wind change and the form of Rossby waves. In order to better illustrate the pattern of thermal variability in temporal and spatial domains, it is helpful for computing zonal and meridional integrals over the images of HSA. The time-latitude plot with zonal integration of HSA shows that the most prominent feature is the 1997-1998 El Nio. The time-longitude plot with meridional integration of HSA also shows the anomalous signal of the onset of 1997 El Nio and more dynamics around 12 N. Comparing with other periods, the HSA of WPWP in 2003, 2004 and 2005 are weaker.

Keywords: thermal variability, western pacific warm pool, empirical mode decomposition

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JMS003 **Poster presentation** **823**

Global observations of ozone isotopes from MIPAS limb emission spectra

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Variations in the isotopic ratios of atmospheric gases can often reveal information about the relative strengths of different sources and sinks of the trace gases in question, and about the transport processes which influence their distributions. The physical and chemical properties of the atmosphere are generally not influenced by the small shift in isotopic composition, therefore, these isotope ratios can be used as valuable tracers for many processes in the atmosphere. The isotopic anomalous enrichment of ozone has been studied in detail in laboratory experiments and it has been observed both in troposphere and stratosphere. Although there is no convincing physical explanation of the process that resultsin these anomalous enrichments, these measurements find that ozone is enriched relative to O2 in both 17O and 18O. The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is a high resolution Fourier transform spectrometer flying on Envisat satellite. MIPAS measures limb emission spectra over a wide spectral range in the middle infrared region (685-2410 cm-1). From July 2002 until March 2004 MIPAS was operated at full spectral resolution (0.025cm-1) with a nominal scanning sequence covering an altitude range of 6-68 km. In March 2004 operations were suspended and in January 2005 were resumed with reduced spectral resolution (0.0625cm-1). For the high-resolution mission ESA have processed pT (pressure-temperature) and six target species. However, MIPAS spectra contain also information on isotopes of ozone as well as other species. Ozone isotopes of molecular mass 49 and 50 are difficult to measure in atmosphere because they are present in the parts per billion range and below. In this study we present the feasibility of retrieving the different isotopes of ozone and their global distributions and enrichments observed by MIPAS. Both laboratory studies and stratospheric balloon samples show consistent results of enrichments below 12% through the middle stratosphere for both ozone isotopes of molecular mass 49 and 50. On the contrary, global distributions of ozone isotopes observed by MIPAS and ODIN-SMR show enrichments of 10-20% in the low and middle stratosphere and higher enrichments (of the order of 40-50%) in the upper stratosphere.

Keywords: mipas, ozone, isotopes

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JMS003 **Poster presentation** **824**

Satellite observations of chlorophyll-a concentration and sea surface wind in the South China Sea

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The South China Sea (SCS) is the largest marginal sea of the Pacific. It is located in the southeastern Asia, covering the ocean area roughly from the equator to 22oN and from 99oE to 121oE. The SCS is also the passageway between the Pacific and Indian Ocean. It connects the Western Pacific, the East China Sea, the Sulu Sea, and the Java Sea through the Luzon Strait, the Taiwan Strait, the Balabac Strait, and the Karimata Strait, respectively. In this study, we try to discuss the spatial and temporal variations of the satellite-derived chlorophyll-a concentration (Chl-a) and sea surface wind (SSW) in the SCS through OrbView-2 satellite SeaWiFS and ERS and QuikSCAT satellite scatterometer data. Mode 1 results of the Empirical Orthogonal Function (EOF) analysis of the Chl-a reveal that the higher Chl-a is mainly along the coastal regions of the SCS, while the mode 2 results emphasize the spatial difference of the Chl-a temporal variation between the eastern and western SCS. It is found that the Chl-a increasing in summer but decreasing in winter along the western coast of the SCS, the reversed situation happens in the eastern SCS. The EOF mode 1 results of the SSW indicate that the winter northeasterly monsoon in the SCS is much stronger than the summer southwesterly monsoon. The mode 2 results show that the zonal area near 15oN can be a boundary to separate the reversed wind patterns in the northern and southern SCS during the monsoon transitional periods, especially in fall. Comparing Chl-a EOF mode 2 and SSW EOF mode 1 results, we can find that Chl-a in the SCS is strongly influenced by the monsoon wind, wind-driven Ekman-pumping coastal upwelling makes the Chl-a increasing along the western SCS in summer and along the eastern SCS in winter. Through the comparison between the Nio 3.4 index and the EOF results of the Chl-a and SSW anomaly data in the SCS, we can see the impact of the El Nio-Southern Oscillation (ENSO) events. It is found that the ENSO effects on the Chl-a in the SCS mainly happen in the coastal regions, the EOF results show that the Chl-a decreases during El Nio but increases in La Nia periods. The EOF mode 2 results of the SSW anomaly data indicate a tremendous weakening of the northeasterly monsoon in the 1997/1998 El Nio winter.

Keywords: chlorophyll a concentration, sea surface wind, south china sea

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JMS003 **Poster presentation** **825**

Estimating column amounts of atmospheric carbon dioxide and methane from high-resolution infrared sounders data

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In accordance with recent studies the existing space borne advanced IR sounders (like AIRS/EOS-Aqua, IASI/MetOp) have the capability to detect the variations of atmospheric carbon dioxide and methane concentration. The ability to reproduce seasonal and inter-annual trend of column-average CO2 mixing ratio (CA(CO2)) and to retrieve the similar characteristic for CH4 (CA(CH4)) from high-resolution spectra measured with above sounders is of significant importance in the context of carbon cycle research, the problem of global warming , and other applications due to the fact that the global network of in-situ (ground-based or airborne) CO2 and CH4 measurements is not yet well established. This presentation describes at first the approach developed for the clear-sky AIRS data inversion and retrieval of the CA(CO2). The sensitivity studies using SARTA simulations enabled to select a set of channels in both SW and LW parts of synthetic AIRS-measured spectra with different (strong and weak) signal responses to CO2 concentration changes; then the CO2-dedicated super-channels have been built as linear combinations of above pre-selected channels in order to suppress the effect of temperature profile T(p) perturbations on the signal in the super-channel (in other words, to reduce the requirements to the accurate knowledge of T(p) in each sounding point). The signal in the CO2-dedicated super-channel is considered as predictor variable in the linear regression estimator for CA(CO2). The performance of developed algorithm of the order of 1% has been evaluated using SARTA-simulated AIRS measurements. The validation effort has also been performed with real clear-sky AIRS data for two areas in Western Siberia (Novosibirsk and Surgut regions) and for several dates of year 2003. The results demonstrate that the estimates of CA(CO2) are representative for a layer between ~3.5 km and about 7-8 km and are consistent with seasonal variations of CO2 concentration derived from in-situ airborne observations. Along with this two approaches have been investigated for the CA(CH4) retrieval from AIRS measurements. The first one and more "traditional" is based upon the physical inversion method and utilizes clear-sky AIRS data in 3 channels within methane absorption band 7.7 m together with the results of collocated AIRS-based retrievals of surface temperature, and temperature/humidity profiles (which are used as input in the retrieval algorithm). The performance of this algorithm of the order of 3-4% has been evaluated using simulated AIRS data. The second approach being similar to that described above for the CA(CO2) estimation utilizes the AIRS data in the CH4 dedicated super-channel. The super-channel has been built in order to reduce the effect of T(p) uncertainties on the accuracy of retrievals. The results of retrieval tests with simulated AIRS data indicate that the same accuracy levels (3-4%) of CA(CH4) estimation can really be achieved with more moderate requirements to the knowledge of T(p) in sounding point.

Keywords: irsounder, retrieval, co2

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JMS003 **Poster presentation** **826**

Comparison of the total ozone, ozone profile, and surface UV radiation measurements at Belsk Observatory (52N, 21E) with the AURA satellite overpasses data in the period 2004-2006

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A comparison of the measurements taken at Belsk (52N, 21E) and collocated OMI and MLS measurements on board of the Aura platform during the site overpasses (2004-2006) is presented. Ground-based measurements of total ozone (by the Brewer spectrophotometer), ozone vertical profile (by the Dobson spectrophotometer), and the surface UV irradiances (by the broad-band biometer) are considered. Satellite data used are: OMI total ozone by DOAS and TOMS V8 algorithm, MLS ozone vertical profile by ver.1.5 and ver.2.2 algorithm, UV daily dose, and UV index. The standard statistical characteristics are calculated: bias, RMS error, the centered pattern RMS difference, and the correlation coefficient from the collocated data pairs. The results of the comparison are visualized on the scatter plot and Taylor diagram. A strong agreement between the individual ozone profiles (bias~ 5%, RMS<10%, the correlation coefficient >0.5) is found in the mid stratosphere (Umkehr layers 5-8) and the upper stratosphere (layer 9). At the lower stratosphere (Umkehr layers 2-4) biases and/or RMS errors are larger but the correlation coefficients are still high (~0.8). Total ozone by the Brewer and the OMI measurements agrees perfectly. The relative difference is 0.9% 1.8% and 1.5% 2.5% for TOMS V8 and DOAS algorithm. A slight SZA dependence is established for the relative differences OMI DOAS minus Brewer total ozone. OMI UV retrieval leads to significant (~10-20%) overestimation of the daily doses and underestimation of UV indices. Large scatter relative to the biometer measurements (RMS error ~20-30%) is also found.

Keywords: atmospheric ozone, surface uvb, satellite validation

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JMS003 **Poster presentation** **827**

Spatial variability of floodplain hydrological cycle with radar altimetry and satellite images. Rio Negro Basin (Brazilian Amazon)

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Global carbon fluxes have generally been evaluated by extraporation of fluxes evaluated by modeling of a determinate floodplain (Richey et al., Nature, 2002). The main question arose by these studies is how the floodplain studies are representative for the extrapolated area. From satellite data, we have evidenced the great spatial variability of the hydrological cycle in the Negro basin floodplain. This variability depends on the connection and the relative location between the main stream and lakes. On the other hand, we have processed both data of ENVISAT RA2 altimeter, and retracked TOPEX/POSEIDON (T/P) GRDs data. The T/P data has been retracked with three of the ENVISAT trackers (Ocean, Ice1, Ice2). An the original 3D method has been employed in order to define virtual stations, and to compute time series of water stage for each individual flooded area. In addition to that, the typology of the inundated area has been determined by the way of satellite image classification coupled with SRTM data.

Keywords: radar altimetry, satellite images, amazon floodplain

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JMS003 **Poster presentation** **828**

Determination of vegetation characteristics from three brazilian study sites using a combination of TRMM-TMI and AVHRR satellite observations

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Since a few years it is possible to retrieve vegetation information from passive microwave observations. The most common technique to do this is based on the inversion of microwave radiative transfer models that link surface geophysical variables to the observed brightness temperatures. The vegetation parameter that is extracted from these microwave observations is called the vegetation optical depth and is a measure for the vegetation transmissivity. The optical depth is largely a function of vegetation water content and biomass, however the conversion from optical depth to these two vegetation parameters is not well understood. The goal of this work is to extract reliable vegetation information from passive microwave observations for different vegetation covers (forest, pasture and cerrado) in Brazil. The forest and pasture areas are represented by the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) sites, ZF2 forest in Cuieiras Reserve (2.60S; 60.21W) and Fazenda Nossa Senhora (10.76S; 62.36W) respectively. For the cerrado region the Barreiras city site (11.96S; 44.9W) was selected, located in Bahia state. From these sites we extracted the vegetation optical depth from observation of the Tropical Rainfall Microwave Mission Microwave Instrument (TRMM-TMI) and converted these values to vegetation water content and biomass using different state of the art methodologies, including the empirical method of Jackson and the more physical based model of Kirdiashev. The results were compared to the Normalized Difference Vegetation Index (NDVI) data from the Advanced Very High Resolution Radiometer (AVHRR) sensor on board the NOAA satellite. The comparison between vegetation water content and NDVI showed similar seasonal patterns for pasture and cerrado, with correlation coefficients (r2) beyond 0.6. Based on the full analyses we can conclude that it is possible to retrieve reliable vegetation parameters from microwave observations for regions with cerrado and pasture vegetation. For the regions with dense vegetation covers the potential to retrieve reliable vegetation information using TMI are limited.

Keywords: vegetation water content, trmm tmi, avhrr

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JMS003 **Poster presentation** **829**

ALTICORE - a consortium serving European Seas with Coastal Altimetry

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The ALTICORE project (value-added ALTImetry for COastal REgions) began in December 2006 and runs for two years thanks to funding provided by the European INTAS scheme (www.intas.be). The main objective of the project is to bridge the current altimetry gap over coastal areas, by improving the quality and availability of coastal altimetry data in European Seas (Mediterranean, Black, Caspian, White and Barents). ALTICORE is a follow-on from the regional ALBICOCCA (ALtimeter-Based Investigations in COrsica, Capraia and Contiguous Areas) initiative. The ALBICOCCA project partners are further strengthened by leading teams from Russia and Azerbaijan. An important aspect of ALTICORE is that it should provide more effective ways of data exchange, in a reliable way, through the development of data management infrastructures that ensure long-term continuity and interoperability, in view of a rapidly growing usage of coastal altimetry.We will summarize the anticipated project stages, namely: 1) improvement of the most widely distributed, 1 Hz, data by analyzing the corrective terms and providing the best solutions, including those derived from appropriate local modelling; 2) development of a set of algorithms to automate quality control and gap-filling functions for the coastal regions; 3) development of testing strategies to ensure thorough validation of the data.We will also outline the design and implementation of a Grid-compliant system for efficient access to distributed archives of improved coastal altimeter data; this consists of regional data centres, each having primary responsibility for regional archives, local corrections and quality control, and operating a set of web-services allowing access to the full functionality of data extraction and integration.We will conclude by discussing a follow-on phase of the project; this will investigate further improvements to the processing strategy, including the use of higher frequency (10 or 20 Hz) data. The whole project aims to promote the 15 years of largely unexploited global altimetry over the coastal areas to the rank of an operational record.

Keywords: altimetry, coastal, grid

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JMS003 **Poster presentation** **830**

An evaluation of the classical and extended Rossby wave theories in explaining spectral estimates of the first few baroclinic modes in the South Pacific Ocean

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Previous literature has suggested that multiple peaks in sea level anomalies (SLA) detected by two-dimensional Fourier Transform (2D-FT) analysis are spectral components of multiple propagating signals, which may correspond to different baroclinic Rossby wave modes. We test this hypothesis in the South Pacific Ocean by applying a 2D-FT analysis to the long Rossby wave signal determined from filtered TOPEX/Poseidon and European Remote Sensing-1/2 satellite altimeter derived SLA. The first four baroclinic mode dispersion curves for the classical linear wave theory and the Killworth and Blundell extended theory are used to determine the spectral signature and energy contributions of each mode. South of 17S, the first two extended theory modes explain up to 60% more of the variance in the observed power spectral energy than their classical linear theory counterparts. We find that Rossby wave modes 2-3 contribute to the total Rossby wave energy in the SLA data. The second mode contributes significantly over most of the basin. The third mode is also evident in some localized regions of the South Pacific but may be ignored at the large scale. Examination ofa selection of case study sites suggests that bathymetric effects may dominate at longer wavelengths or permit higher order mode solutions, but mean flow tends to be the more influential factor in the extended theory. We discuss the regional variations in frequency and wave number characteristics of the extended theory modes across the South Pacific basin.

Keywords: south pacific ocean, rossby waves, baroclinic modes

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JMS003 **Poster presentation** **831**

Inversion of surface roughness parameters of intertidal mudflat from airborne polarimetric SAR data

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The coastal zone of Korean peninsula is well known for its large tidal range and a vast expanse of intertidal flats. In this paper, methods of extracting the roughness of the scattering surface of intertidal mud flats from polarimetric SAR data are investigated. The L-band NASA/JPL airborne SAR (AIRSAR) data, which were acquired on the intertidal zone during PACRIM-II campaign on September 30, 2000, were used for this research to estimate the roughness of the tidal mud flats in the "Yeoja Bay" study area. The study area is famous in as the nations leading cockle production area. Surface roughness can be used as a key parameter for describing the land-use characteristics in the intertidal flats. The vertical and horizontal roughness parameters "ks" and "kl" were estimated from co- and cross polarization backscattered coefficients using Integral Equation Model (IEM) and the semi-empirical model. Furthermore roughness parameters were estimated from circular polarization coherence as well as the coherency matrix element using the extended Bragg model. The use of polarimetric decomposition techniques was introduced in order to mitigate the disturbing influence of secondary scattering processes and reduce system noise. Roughness inversion algorithms proposed in this paper are useful to estimate the biogenic and physical roughness structures as well as fishery induced roughness disturbances in the intertidal mudflats.

Keywords: polsar, surface scattering, roughness

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JMS003 **Poster presentation** **832**

Geophysical validation of MIPAS/ENVISAT temperature

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The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is operating on the ESA ENVIronmental SATellite since March 2002. The high resolution (0.035 cm-1) measurements acquired by MIPAS in the first two years of operations constitute a self-consistent set of data with very good geographical and time coverage. These measurements have been re-processed by ESA up to Level 2, with the most recent versions of both Level 1b and Level 2 algorithms. The products of the ESA Level 2 algorithm are geolocated profiles of temperature and of volume mixing ratio of six key atmospheric constituents: H2O, O3, HNO3, CH4, N2O and NO2. As for all the measurements made with innovative instruments and techniques, this data set requires a thorough validation. During the last two years, a large team of European scientists spent great efforts in the validation of this data set (technically labelled with versions 4.61 and 4.62). In particular, the authors of this paper have focused their activities on the validation of temperature. The validation was carried-out by comparing MIPAS retrieved temperature with correlative measurements made by radiosondes, lidars, in-situ and remote sensors operated from stratospheric balloons. The results of the intercomparison indicate that MIPAS profiles are affected by an altitude-dependent bias generally smaller than 1 or 2 K, depending on the altitude. Furthermore we find that, especially at the edges of the altitude range covered by the scan, the MIPAS random error estimated from the intercomparison is larger (typically from a factor two to three) than the corresponding estimate derived on the basis of error propagation.

Keywords: limb emission, retrieval, temperature

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JMS003 **Poster presentation** **833**

An athmospheric forward model to deduce solar induced chlorophyll fluorescence from radiance spectra of leaves in the oxigen absorption bands

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Marina Mazzoni, Pierluigi Falorni, Bruno Carli

Chlorophyll fluorescence is well known as indicator of photosynthetic activity and vegetation health state. Furthermore, as the shape variation of the red-edge region (from 650 nm to 800 nm) of vegetation spectra were proved to be correlated to the stresses induced on the leaf, high resolution reflectance spectra are also useful by itself, and also for the correct interpretation of the fluorescence signal. In the proximity of the atmospheric oxygen absorption bands, it is possible to process complete spectra, of solar radiance reflected from a reference panel and of leaf radiance, to give accurate lineshapes of both reflectance and fluorescence. Owing to the resolution of the dispersion and detection system, which was limited to about 0.03 nm mainly for the finite dimension of the array elements (25 micronm) of the intensified diode array used for detection, not all the lines within each oxigen bands are fully resolved. Simulated spectra of solar radiance in the atmospheric absorption lines were deduced with a forward model by solving the radiative transfer equation at high resolution and were convolved with the instrument lineshape to fit the reference panel spectrum and the leaf radiance spectrum for fluorescence and reflectance retrieval.

Keywords: chlorophyll, fluorescence, forward model

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JMS003 **Poster presentation** **834**

Monitoring of the surface instability of urban areas using INSAR time series of space-borne SAR data

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Sang-Eun Park, Wooil M. Moon

The SAR interferometry (or InSAR) and the differential SAR interferometry (D-InSAR) is a favorable tool to monitor Earths surface relief and deformation, including precursors to volcanic activitie, earthquake related dislocations, glacial movement and various other surface deformations. An advanced form of D-InSAR using the time series of differential interferograms was published by Ferretti et al, (2000)Persistent Scatterer Interferometric SAR. The PSInSAR can overcome the problems from inaccurate DEM and the additional interferometric phase due to the atmosphere, which are the main factors hindering the application of D-InSAR. This paper presents the results of the PSInSAR application on the urban area. One of the more unstable areas on Earth is coastal reclaimed lands. A large portion of the study area, Incheon in Korea, is constructed on the reclaimed land. We used the 27 JERS-1 SAR data which was acquired for the time span between 1992 and 1998. By analyzing its orbit and acquisition time, the master image is selected to make maximum available SAR interferograms of which normal baselines are not too large so that the coherence of the interferograms are not to be lost. Among 26 interferograms, 23 were available, and of which normal baseline vary to 3000 meter and the time baseline is up to 3 years. PSInSAR technique requires external DEM to make differential interferogram. Shuttle Radar Topography Mission (SRTM) data were used. The result of the surface deformation monitoring shows that small portion of the study area was unstable. The most prominently subsided area is located on the reclaimed land which was reclaimed about 30 years ago. It is thought that the weakening of the reclaimed land caused the subsidence. Other smaller subsidences were observed along subway constructions. The subway construction requires continuous drainage of ground water to make the subway tube stay above the water table. It usually causes the reduction of the pressure to thrust up the ground against gravity and the surface subsides during the constructions. We also analyzed the one-year periodic deformation of the persistent scatterers throughout the observation period. There was no spatial correlation of the amplitude. However, we can find the consistence between the one-year periodic air temperature variation and the deformation of persistent scatterers. It is interpreted that the persistent scatterers in the urban areas are under the influence of the thermal expansion and contradiction. The displacement of Earths surface is successfully monitored over several sites although there are no ground truth measurements. The PSInSAR technique is expected to be applicable to monitor the instability of Earths crust such as the volcanic activity and the pre-seismic movement.

Keywords: insar, remotesensing, surfacedeformation

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JMS003 **Poster presentation** **835**

Simultaneous views of aerosol events from the A-Train

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The A-Train satellite formation offers unprecedented opportunities for the synergistic study of several important areas related to Earth and its atmosphere. With the launch of CALIPSO and CloudSat in April 2006, five of the six planned satellites are now in place, making nearly coincident measurements of water, aerosols, clouds, and chemical constituents in the Earth/atmosphere system. The A-Train comprises two NASA Earth Observing System (EOS) missions, Aqua and Aura; three Earth System Science Pathfinder (ESSP) missions, Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO), CloudSat, and, in 2008, the Orbiting Carbon Observatory (OCO); and a mission from the French Centre National dEtudes Spatiales (CNES), Polarization and Anisotropy of Reflectances for Atmospheric Science coupled with Observations from a Lidar (PARASOL). Named for its afternoon equator crossing at 1:30 pm local time, the A-Train travels in tight formation with only about fifteen minutes between the leading and trailing satellites. The near-simultaneous measurement of atmospheric parameters globally and over time will allow data from these different satellites to be used together to provide new understanding of atmospheric processes. In particular, the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) on CALIPSO, the Tropospheric Emission Spectrometer (TES) on Aura, the MODerate Resolution Imaging Spectroradiometer (MODIS) on Aqua, and the POLarization and Directionality of the Earths Reflectances (POLDER) instrument on PARASOL provide information about aerosol particle properties, their distribution, both horizontal and vertical, and the chemical composition of the atmosphere. These data can be combined to develop a more complete characterization of aerosol phenomena such as dust storms, biomass burning, and pollution events. Data from these instruments, including CALIPSO and TES data available from the Atmospheric Science Data Center (ASDC) at NASAs Langley Research Center, are used to demonstrate complementary views of specific aerosol events. CALIOP is a two-wavelength polarization-sensitive lidar with 30 meter vertical resolution and 333 m horizontal resolution. It measures vertical profiles of the atmosphere and provides information on the vertical and horizontal distributions of aerosols and clouds and their properties. MODIS makes measurements in 36 spectral bands at 250 meter, 500 meter or 1 kilometer resolution, viewing the entire Earth's every 2 days, and derives aerosol parameters including aerosol optical thickness, type, and size distribution. The POLDER instrument measures in nine spectral bands, three of which have polarizing filters. The instruments wide field of view makes it possible to see the same scene from several viewing angles, providing directional information. POLDER Level 2 aerosol parameters include aerosol optical thickness, sphericity, and Angstrom exponent. The TES instrument is a high-resolution imaging infrared Fourier-transform spectrometer that operates in both nadir and limb-sounding modes. TES standard Level 2 data products include global-scale vertical profile and total column measurements of ozone, water vapor, carbon monoxide, methane, and nitric acid for 16 orbits every other day. The ASDC provides data access, services and tools for over 35 projects in the discipline areas of Earths radiation budget, clouds, aerosols and tropospheric chemistry. Additional information is available from our web site, http://eosweb.larc.nasa.gov.

Keywords: aerosol, lidar, data fusion

CALIPSO and MISR aerosol data available for atmospheric research

Mrs. Nancy Ritchey

Linda A. Hunt, Michelle T. Ferebee

The Atmospheric Science Data Center (ASDC) at NASA Langley Research Center processes, archives and distributes data relating to aerosols, the Earth's radiation budget, clouds, and tropospheric chemistry. Global aerosol measurements and aerosol characteristics are contained in many data products available from ASDC. This paper focuses on the satellite instruments Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), part of the A-Train constellation, and Multi-angle Imaging SpectroRadiometer (MISR), currently orbiting on the Terra satellite. CALIPSO was launched into a sun-synchronous orbit on April 28, 2006, where it joined the A-Train constellation. The primary objective of CALIPSO's three-year mission is to make a global survey of the vertical structure of clouds and aerosols and their physical properties needed to improve climate predictions. CALIPSO comprises three instruments, the Cloud-Aerosol LIdar with Orthogonal Polarization (CALIOP), an Imaging Infrared Radiometer (IIR), and a Wide Field Camera (WFC). CALIOP is a two-wavelength, polarization-sensitive lidar that provides information about the composition of clouds, the abundance and sizes of aerosols, and the altitudes of cloud and aerosol layers. The IIR measures outgoing radiation at three wavelengths in the thermal infrared window (8.65 mm, 10.6 mm, and 12.0 mm) to determine cloud emissivity and particle size. The high resolution, nadir-viewing WFC images the region around the lidar footprint in a single spectral channel (645 nm). CALIPSO Level 2 aerosol data products include an aerosol layer product at 5 km resolution (height, thickness, optical depth, and integrated attenuated backscatter) and an aerosol profile product with a horizontal resolution of 40 km and vertical resolution of 120 m (backscatter, extinction, and depolarization ratio). MISR has been operating continuously since its launch on December 18, 1999 on the Terra satellite. MISR collects multi-angle as well as multi-spectral data never before obtained by satellite instruments. The additional information contained in these data make it possible to set limits on particle size and composition, as well as aerosol amount, measured over ocean. These data are also used to derive aerosol properties in the atmosphere over heterogeneous land and dense dark vegetation. Different methods to derive aerosol properties over different types of surface are used. MISR also uses a systematic, global monitoring program to collect data about particle type and amount. This data product, known as Clim-Likely, is used in studies of the planetary energy balance, and for modeling regional and global trends in Earth's climate. MISR Level 2 aerosol data product contains tropospheric aerosol optical depth, aerosol physical model, Angstrom exponent and single scattering albedo on 17.6 km centers, aerosol mixture identifier and related parameters. MISR Level 3 global aerosol optical depth is available on a 0.5 by 0.5 resolution grid averaged over daily, monthly, seasonal and annual time scales. This product is available in HDF-EOS and NetCDF file formats. Additional information about all ASDC data products, images and tools is available from the ASDC web site, http://eosweb.larc.nasa.gov. ASDC data are distributed free of charge.

Keywords: aerosol, aerosol characterization, satellite observations

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JMS003 **Poster presentation** **837**

Comparison of the different integrated water vapor estimations based on MODIS and ECMWF data for Hungary

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Remote sensing provides a very efficient way to quantitatively estimate the water vapor content of the atmosphere in high spatial and temporal resolution. Besides, atmospheric water vapor is estimated in several places worldwide using the signal of the GPS (Global Positional System) satellites, measured in a network of ground-based meteorological stations, and also, in a sparse network of radiosondes. Many techniques have been proposed in literature to estimate atmospheric water vapor content using satellite data, primarily in the form of total column precipitable water, using a variety of electromagnetic spectrum. The presented research activity is based on the data acquired by the HRPT/MODIS (High Resolution Picture Transmission, MODerate resolution Imaging Spectroradiometer) receiving station located in Budapest, Hungary. The integrated water vapor (IWV) is estimated by the remotely sensed data of the MODIS instrument onboard satellite Terra and Aqua with different methods and also by the operational numerical weather prediction model of the European Centre for Medium-Range Weather Forecasts (ECMWF). We used radiosonde data to evaluate the accuracy of the different IWV estimations. It was found that both the MODIS and the ECMWF based fields are of good accuracy, but the satellite data represents finer scale spatial structures as the ECMWF data, and thus it can not be negligible. The temporal variability of IWV was also investigated using both ECMWF and MODIS data. The high quality IWV fields have proved to be useful for radiative transfer studies such as the atmospheric correction.

Keywords: integrated water vapor, modis, ecmwf

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JMS003 **Poster presentation** **838**

Remotely sensed atmospheric profiles for the Carpathian Basin

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Remotely sensed atmospheric profiles provide essential information about the vertical structure of the atmosphere, which can be useful in many scientific studies due to its high horizontal resolution. Since 2002, the Faculty of Science at the Etvs Lornd University (Budapest, Hungary) operates a satellite receiving facility. This station currently receives Earth observation data from the NOAA and Terra/Aqua polar orbiting environmental satellites. Using the AAPP (ATOVS and AVHRR Processing Package) and IAPP (International ATOVS Processing Package) software packages we are able to derive atmospheric profiles of temperature, water vapor mixing ratio, etc. from the data of the Advanced TIROS Operational Vertical Sounder (ATOVS) instrument onboard the NOAA satellites. Using the International MODIS/AIRS processing package (IMAPP) software we are able to transform the Terra and Aqua based Moderate Resolution Imaging Spectroradiometer (MODIS) Level 1A raw data into Level 2 science products, such as the MOD07 product containing atmospheric profiles of the same parameters. Temperature inversion is a specific and frequent synoptic situation in the Carpathian Basin during the winters. Our aim is to compare and verify the temperature, humidity profiles, and the cloud products retrieved from the measurements of different satellite based instruments. We use radiosonde data for validation.

Keywords: temperature profile, humidity profile, modis

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JMS003 **Poster presentation** **839**

Stream network extraction using remotely-sensed DEMs

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The automated extraction of drainage networks using digital elevation models (DEMs) is a common practice among hydrologic and geomorphic modellers. Although, DEM-based flow direction methods are prevailing over vector-based approaches due to the increasing availability, resolution and precision of remotely-sensed DEM, there are some drawbacks linked to the gridded structure of raster elevation data, and other unresolved issues related to the correct interpretation of some critical DEM features like artificial depressions (pits) and flat areas. In this contribution a quantitative analysis of SRTM and ASTER DEM performances in the correct extraction of stream network, is developed, with particular focus on the analysis and treatment of pits and flat spot. Six different flow direction algorithms, in conjunction with different artificial depression and flat area removal approaches, are applied on a wide range of heterogeneous climatic conditions. Several case studies are analysed using objective indices to quantify differences of model results as respect to the ground-truth of digitized channels.

Keywords: flow direction, dems, flat areas

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JMS003 **Poster presentation** **840**

Impact of scene non-uniformity on space-based sensor product validation

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D. Zhou, X. Liu, W. Smith

Advanced space-based sensors are tasked with improving measurements of the Earths atmosphere, clouds, and surface to enable enhancements in weather prediction, climate monitoring capability, and environmental change detection. Measurement system validation is critical to achieving this goal and maximizing research and operational utility of resultant data products. This enables the ability to separate instrument response changes from true geophysical variability, which is needed to understand and correctly interpret long-time-series data coming from multiple instruments on multiple platforms. Uncorrected errors in radiometric, spectral, and spatial calibration can all negatively impact the quality of directly-measured radiances and derived geophysical quantities. This study will address some of the challenges associated with validating infrared radiances, with a focus on the impact of scene non-uniformity in performing this task. The analysis presented incorporates data from the Atmospheric InfraRed Sounder (AIRS) and the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Aqua satellite, as well as high-altitude airborne interferometric measurements from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Airborne Sounder Testbed--Interferometer (NAST-I) from recent field campaigns. Methodology employed herein will soon be applied to validation of the newly-launched Metop IASI sensor along with other, future advanced hyperspectral and ultraspectral systems.

Keywords: infrared spectral radiance, validation fts, scene non uniformity

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JMS003 **Poster presentation** **841**

Precipitable Water Vapor estimation over the Korean peninsula using the continuous GPS network

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Korea Astronomy and Space Science Institute (KASI) is continuously operating nine GPS reference stations including one IGS station. The digital meteorological sensors were installed on whole stations by June in 2006 to measure precisely the surface pressure, temperature and relative humidity of the KASI's stations. We developed the programs which collects data from each receiver to the main KASI GPS center using the TCP/IP and translates the binary data of the digital sensor to a RINEX data. To check influence of the digital sensor, we compared the results which use the nearby automated weather station (AWS) data and the data from the digital sensor located in GPS stations. The result which uses the digital sensor data shows the better accuracy of the PWV results from 0.8 mm to 16.6 mm than the use of the AWS data. We processed the KASI GPS network data from July to August in 2006, and obtained the PWV values. As the results, KASI's GPS PWV information is provided by on-line service. Recently, we are developing the near real-time system for obtaining the GPS PWV and investigating how to assimilate the GPS PWV to the numerical weather prediction model. The near real-time GPS PWV information will be also served on the web site.

Keywords: pwv, gps

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JMS004 **842 - 845**

Symposium
Intercontinental Transport of Substances and its Consequences

Convener : Dr. Anne Thomson

What comes around goes around is one way to express the phenomenon of long-range transport of pollution from continent to ocean to continent, often reaching far around the world. Examples of intercontinental transport of non-welcome substances include dust, soot, sulfate aerosols, ozone, CO, and a number of reactive trace gases having lifetimes in the atmosphere of days to weeks. Sources can include megacities and extended urbanized regions as well as eroding and unvegetated land. Pollutant plumes can leave one continent and cross an ocean or even return to the same continent after extended travel over the oceans. This symposium invites papers on issues regarding the long-distance transport of pollution of all sorts, including studies carried out based on observations, field experiments, and models

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JMS004 **Oral Presentation** **842**

Phytoplankton blooms associated with dust transport across the Arabian Sea

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The Arabian Sea is a unique and one of the most dominant oceanic basin receiving frequent dust storms, originating from its surrounding arid and semi-arid regions. These dust storms carrying fine mineral particles, when get deposited on the ocean waters are found to be responsible for most of the phytoplankton blooms across the Arabian Sea. In the present paper, we have made efforts to understand the influence of these dust storms on chlorophyll concentrations (which are commonly used as an indicator of phytoplankton presence) in the Arabian Sea for the period 20032006. Moderate Resolution Imaging Spectroradiometer (MODIS) and Indian Remote Sensing (IRS) P4 Ocean Color Monitor data have been used to study the chlorophyll concentrations prior to and after the dusty days. Our study has been carried out in five sub regions across the Arabian sea in the interval of 0.5 degree latitude and from west to east in the region bounded by 24N, 60.0-66.0E; 23.5N, 60.5-66.5E; 23N, 60.5-67.0E; 22.5N, 61.0-67.5E and 22N, 61.0-67.5E. We have considered the area about 50 km away from the coastal line to minimize the effect of river input nutrients and other coastal processes. Detailed analysis of parameters such as chlorophyll concentrations, aerosol optical depth and sea surface temperature from MODIS data clearly show the influence of dust deposition on the surface of the Arabian Sea. Our results show a pronounced increase in chlorophyll concentrations of nearly 35 times, after every dust storm passage with a lag time of 2448 hours. The chlorophyll blooms deduced from MODIS satellite are compared with IRS P4 OCM data and found to be in good agreement. The continuous monitoring of such phytoplankton blooms over the world oceans provide a good understanding of the interaction between the land-ocean-atmosphere and long term changes in the marine ecosystem.

Keywords: dust, arabian sea, phytoplankton

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JMS004 **Oral Presentation** **843**

A study of Asian dust using MODIS satellite observations and DC-8 in situ measurements during the INTEX-B field experiment

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Xiquan Dong, Baike Xi

During the months of April and May in 2006 over the eastern Pacific Ocean, the Intercontinental Chemical Transport Experiment-B (INTEX-B) was conducted as the second phase in a two phase experiment called INTEX-North America (INTEX-NA) that sought to understand and assess the impact on air quality and climate of the transport and transformation of gases and aerosols at transcontinental and intercontinental scales. The NASA UND DC-8 aircraft platform in this experiment measured the aerosol properties over ten separate flights and a total of 75 hours between Hawaii and Alaska with the differential absorption lidar (DIAL) and wing mounted aerosol probes. The DIAL measured the aerosol backscattering profile in the visible (588 nm) and infrared (1064 nm) wavelengths along with total depolarization with a vertical resolution of 30 meters and about 230 meters in the horizontal with a 10 second interval from the surface to above the tropopause along the DC-8 flight track. These in situ measurements have been used to compare with the MODIS retrieved aerosol optical depth (AOD, MOD4) on the Terra and Aqua satellites. Both MODIS retrieved AOD and DC-8 lidar measurements have shown that Asian Dust events occurred over eastern Pacific Ocean during the 17 April to 12 May period. Based on 15 hours of DC-8 in situ measurements and MODIS retrievals, we conclude that for Asian dust events their AOD values are above 0.4, total depolarization is 25% or greater and visible scattering ratios are above 5. These are much higher than their corresponding dust-free values, such as AOD=0.05, total depolarization =10%, and visible scattering ratio=0.5. A further quantitative comparison is warranted.

Keywords: asian dust, satellite observations, intex b

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JMS004 **Poster presentation** **844**

Trans-Eurasian Pollution Transport Study by Mobile Railway Laboratory TROICA

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Study of Trans-Eurasian pollution transport is important but difficult task cause of lack of direct observations on huge territories of the Northern Eurasia. The unique experiment TROICA (Transcontinental Observations Into the Chemistry of the Atmosphere) has provided continent scale measurements of numerous atmospheric species and characteristics across Russia since 1995. TROICA data contributed a lot to our knowledge about spatial and temporal variations of small gases and aerosols in the Northern Eurasia. Till present 8 campaigns (16 runs in both directions) have been performed along Trans-Siberian railway, 1 campaign has covered railroad Murmansk-Kislovodsk and last campaign occurred in October, 2006, included 3 circle runs around Moscow. TROICA results revealed spatial gradients of some substances depending on anthropogenic polluting emissions (NO2, CO, SO2, SF6, O3, BC) from West to East according to prevailing air mass transport. Concentrations of most polluting species decrease eastward while ozone surface ratio increases in eastern direction by 1-1.5 ppbv per 1000 km. Some enhancements of CO and BC are caused by wild forest fires as well as by seasonal biomass burning in agriculture. Those substances can be transported for hundreds kilometers for source. Methane transport from gas fields in Western Siberia can also reach remote sites. It is more difficult to follow transport of volatile organic compounds. The situations when local ozone photochemical generation can be induced by transported organic are considered. The analyses of different substances transport was carried out using GIS ArcInfo 9.0 with added TROICA layers, HYSPLIT NOAA trajectory model as well as combination of hydrodynamical model RAMS and transport model HYPACT. Perspectives of further study of Trans-Eurasian pollution transport are also connected with involvement of stationary observations data, in particular, with Zotino station in the Central Siberia that has been recently launched. The work is fulfilled under support of International Scientific and Technology Center (ISTC Projects #2773 and 2770).

Keywords: pollutants, transport, eurasia

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS004 **Poster presentation** **845**

Influence of airmass transport on atmospheric CO2 and CH4 in the Mediterranean

Dr. Artuso Florinda
Climate Department ENEA- Italian National Agency of New Technologies,

Paolo Chamard, Alcide Di Sarra, Daniela Meloni, Francesco Monteleone, Salvatore Piacentino, Damiano Sferlazzo

Measurements of carbon dioxide (CO2) mixing ratios in atmosphere have been started on a weekly basis, at Lampedusa island (35.5N, 12.6E), in the Mediterranean, by ENEA (Italian National Agency for New Technologies, Energy and the Environment) in 1992 as a part of the monitoring program of greenhouse gases. Methane (CH4) is also routinely measured since 1995.In this work weekly CO2 and CH4 data sets have been analysed in order to study the interannual variability of mixing ratios and growth rates. Both CO2 and CH4 time series show an increasing trend. Growth rates of CO2 and CH4 are in phase with each other and display two peaks, in 1998 and at the end of 2001 (about 4.2 and 3.9 ppm/yr for CO2 and 19 and 14 ppb/yr for CH4 respectively).Evaluation of the influence of long and short range transport on CO2 and CH4 behaviour has been carried out following two different approaches respectively: backward airmass trajectory method and wind direction analysis.Trajectories have been calculated by using the HYSPLIT dispersion model provided by National Oceanic and Atmospheric Administration/Air resources Laboratory. To identify the regions originating the airmasses, the time spent by each trajectory in a defined geographical sector or latitute band, has been considered. The deviations of the weekly mixing ratio records from the detrended 13-week running mean, defined as d, have been associated with each airmass back trajectory. A latitudinal gradient is evident for both species, with largest values of d in the Northern sector (dCO2= 0.2 ppm; dCH4= 6.2 ppb), and smallest in the Southern sector(dCO2= -1.2 ppm; dCH4= -10.9 ppb), according to what expected from the latitudinal distribution of sources. Geographical sector analysis remarks the influence on CH4 atmospheric abundance due to emissions from gas production and leakage from the gas pipelines coming from North Algeria and Russia.Wind direction analysis confirms the influence of airmass origin on the observed evolution of CO2 and CH4 records. Prevalent winds at Lampedusa are from North-North West (52% of the cases during the flask samplings). Winds originating from this sector (from 315 to 45) are characterized by higher d values of CO2 and CH4. The highest values of d for CH4 (8.0 ppb) are associated to wind direction episodes from North-West of the island, between 266 and 278, where a waste disposal system is located. This results highlights the influence of the local sources.

Keywords: transport, co2, ch4

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JMS005 **846 - 882**

Symposium
Aerosols, Biomass Burning and Precipitation

Convener :
Co-Convener : Prof. Ulrike Lohmann, Prof. Zev Levin

This session will explore recent progress in our understanding of the interactions between atmospheric aerosols and biomass burning, and precipitation and their implications for the Earth's climate. We encourage contributions of the role of aerosols on the formation and evolution of water and ice clouds, on the impact of aerosols on cloud microphysical properties, and especially on the processes that lead to the formation of precipitation. The session encourages presentations on the implications of aerosol-cloud-precipitation interactions for climate and atmospheric chemistry. The presentations will include reports on field campaigns and laboratory studies, theoretical investigations, and modeling studies at all scales

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JMS005 **Oral Presentation** **846**

Case studies of precipitation over Tehran area on impact particle pollutants

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S. Azojy

The relationship between precipitation and particle pollutants in Tehran as metropolitan city has been investigated. This study plays an important role for meteorologists and environmental researchers. The influence of particle pollutant on precipitation process in various regions of Tehran including Northeast (Aghdasie), Northwest (Geophysics), East (Sorkhe hesar), West (Mehr Abad) and the center (Bazar) has been studied .These investigations has been proceed in two ways: desirable days (particle pollutants less than 100 µg/m3) and undesirable days (particle pollutants more than 200 µg/m3) in warm and cold seasons in a period of 5 years (1999 2003). The analysis of isohypse /particle pollutant isograms in undesirable conditions for each precipitation event show that in both warm and cold seasons the amount of precipitation during the day increases from downtown toward the north of city, due to decrease of particle pollutant concentrations. The averages of precipitation in Northern stations are higher than central, Western and Eastern stations due to their higher elevations. These average in undesirable days decreases from Westside to East and increase in desirable days. The precipitation trends increases for all stations in desirable conditions in warm and cold seasons and decreases in undesirable conditions. Study of all data in desirable and undesirable days in cold and warm seasons shows that, in desirable condition the precipitation trends increase, probably due to inadvertent cloud seeding. In undesirable condition due to increase of particle pollutants as cloud condensation nuclei (CCN), the precipitation trends decrease probably due to cloud over seeding. Majority of stations in warm season shows that the maximum value of precipitation in desirable and undesirable days are a bit more than its value at clod season , mainly due to higher thickness of clouds and more precipitation intensity in warm season.

Keywords: particle pollutants, cloud condensation nuclei, inadvertent cloud seeding

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JMS005 **Oral Presentation** **847**

Analysis of aerosol features over the Indian Region during ICARB period using satellite data

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Aerosol data from MODIS (Moderate Resolution Imaging Spectroradiometer) and MISR (Multiangle Imaging Spectroradiometer), NCEP (National Centre for Envioronmental Prediction) reanalysis meteorological fields, QuikSCAT (Quick Scatterometer) ocean surface winds and the ICARB (Integrated Campaign for Aerosols, Gases and Radiation Budget, March 16 May 11, 2006) observations are utlised to study the dynamics of aerosol transport and to identify aerosol generation sources over the Indian land mass and the surrounding oceans. At the beginning of the campaign, aerosol optical depth (AOD) was moderately high in the central and north western regions of the subcontinent and over the Indo-Gangetic plain due to the injection of marine aerosols from the ocean and mineral dust from the arid region in the western part of the continent by the prevailing wind field in the north eastern parts of the Arabian Sea. Subsequent steady increase in wind speed together with the change in wind direction from north westerly to south westerly intensified the aerosol injection resulting in an enhancement of AOD over the entire land mass by March to May. But all through the period, the fine mode component of aerosols remained confined mostly to the eastern parts of the Indo-Gangetic plain and the east coast of India. Over the oceans, the moderately high aerosol loading (AOD ~ 0.2 - 0.3) near the coasts in March intensified towards the end of the campaign in the northern and the southeastern Arabian Sea and in the north western Bay of Bengal. A pocket of high AOD located in the south eastern Arabian sea in March intensified and expanded into the far oceanic regions accompanied by an increase in its fine mode fraction. The presence of a high AOD region (with values exceeding 0.45) of size ~ 3x3 in the north western Bay of Bengal (around 18 N, 85E) observed in MODIS data in the last week of March and confirmed further by the direct measurements carried out on board ORV Sagar Kanya could be attributed to subsidence induced by a strong vorticity seen in the NCEP winds at 925 hpa level. This analysis shows that over the land the AOD variations are mainly modulated by wind convergences while over the oceans, atmospheric subsidence caused by wind vorticity is found to be the prime mechanism determining the spatial distribution of AOD.

Keywords: aerosols, satellite, transport

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JMS005 **Oral Presentation** **848**

Global impacts of anthropogenic aerosols on convective clouds and precipitation

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Aerosols are an integral part of the atmospheric hydrological cycle and the atmospheres radiation budget, with many possible feedback mechanisms that are not fully understood yet. Human activities modify through direct emission and secondary formation processes aerosol parameters and cloud properties in warm, mixed-phase and ice clouds. Interactions of aerosols with the hydrological cycle occur through the role of aerosols in cloud microphysical processes, as aerosol particles act as cloud condensation nuclei and ice nuclei. Because clouds in mid-latitudes originate predominately via the ice phase, changes of the properties of ice nuclei are of crucial importance for the hydrological cycle. An increase in ice nuclei can result in a rapid glaciation of a supercooled liquid water cloud due to the difference in vapour pressure over ice and water. Unlike cloud droplets, these ice crystals grow in an environment of high supersaturation with respect to ice, quickly reaching precipitation size, and with that can turn a non-precipitating into a precipitating cloud (glaciation effect). The global impact of aerosols on convective clouds is not known yet. Previous estimates of changes in convective precipitation from individual cloud systems due to anthropogenic aerosols are inconclusive, with suggestions for precipitation enhancement or suppression (Lohmann and Feichter, 2005). In this presentation, I am going to evaluate the impact of anthropogenic aerosols on convective clouds and precipitation globally using the ECHAM5 general circulation model (Roeckner et al. 2003). ECHAM5 includes a double moment aerosol microphysics scheme ECHAM5-HAM that predicts the evolution of an ensemble of microphysically interacting internally- and externally-mixed aerosol populations as well as their size distribution and composition (Stier et al., 2005). The size-distribution is represented by a superposition of log-normal modes. In the current setup, the major global aerosol compounds sulfate, black carbon, particulate organic matter, sea salt, and mineral dust are included. The cloud scheme, originally developed for stratiform clouds and recently extended also to convective clouds, predicts the number and mass mixing ratios of cloud droplets and ice crystals (Lohmann et al., 1999; Lohmann, 2002; Zhang et al., 2005). Results from the coupled ECHAM5-HAM - cloud microphysics scheme will be compared with different present-day observations. Thereafter sensitivity simulations with present-day aerosol concentrations will be compared with simulations with pre-industrial aerosol concentrations in order to evaluate the impact of anthropogenic aerosols on convective clouds and precipitation globally and in different geographical regions and seasons. References: Lohmann, U., J. Feichter, C. C. Chuang, and J. E. Penner, 1999: Predicting the number of cloud droplets in the ECHAM GCM. J. Geophys. Res., 104, 9169-9198. Lohmann, U., 2002: Possible aerosol effects on ice clouds via contact nucleation. J. Atmos. Sci., 59, 647-656. Lohmann, U. and J. Feichter, 2005: Global indirect aerosol effects: A review. Atmos. Chem. Phys., 5, 715-737. Roeckner, E., G. Buml, L. Bonaventura, R. Brokopf, M. Esch, M. Giorgetta, S. Hagemann, I. Kirchner, L. Kornblueh, E. Manzini, A. Rhodin, U. Schlese, U. Schulzweida, and A. Tompkins, 2003: The atmospheric general circulation model ECHAM5. PART I: Model description, Max-Planck-Institut fr Meteorologie Technical Report No. 349, 127pp. Stier, P., J. Feichter, S. Kinne, S. Kloster, E. Vignati, J. Wilson, L. Ganzeveld, I. Tegen, M. Werner, Y. Balkanski, M. Schulz, O. Boucher, A. Minikin, and A. Petzold, 2005: The aerosol-climate model ECHAM5-HAM. Atmos. Chem. Phys., 5, 1125-1156. Zhang, J. H., U. Lohmann, and P. Stier, 2005: A microphysical parameterization for convective clouds in the ECHAM5 climate model: Single-column model results evaluated at the Oklahoma Atmospheric Radiation Measurement Program site. J. Geophys. Res., 110, D15S07

Keywords: convective clouds, aerosol impact on precip, climate modelling

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JMS005 **Oral Presentation** **849**

Aerosol impact on extreme weather and climate events,

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Within the frame of Fundamental RAS Program Natural catastrophes during year of 2006 was launched the new subprogram named Hydrometeorological and geophysical catastrophes. The main goal of the project Possibilities of aerosol impact on extreme meteorological processes and situations is to investigate ways and results of different types of atmospheric aerosol impact on extreme weather and climate events. The presentation contents analysis of known methods of aerosol impacts on clouds and precipitation and overview of hierarchy aerosol impact on extreme weather and climate events. History and problems in weather modification as well as aerosol impact on clouds and precipitation are discussed. The special attention is given to new geoengineering ideas like sulphate climate cooling by burning sulphur and delivering sulphate aerosol into the troposphere and stratosphere. Its shown that processes of SO2 hidrolisis and condensation of sulfuric acid particles lead to aerosols transport in the top layers of stratosphere, reduction of H2O, convective transport changes in stratosphere and possible increase of stratospheric clouds.

Keywords: catastrophes, climate, aerosol impacts

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JMS005 **Oral Presentation** **850**

Impacts of Inter-annual Variability of aerosols Index on Precipitation over Sudano-Sahel Region of Nigeria

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In this study, an attempt is made to x-ray the impacts of inter-annual variability of dust Aerosol Index (AI) on precipitation regime over Sudano-Sahel Region of Nigeria; using Total Ozone Mapping Spectrometer Aerosol Index (TOMS-AI) satellite observation, and rainfall parameters from synoptic station in the region. Using Kendalls Rank Correlation trend test and variability test, analyses of 25-year TOMS Aerosol Index data and 60-year rainfall data reveal that inter-annual variability and trend exist in the time series of the region. Average TOMS AI for 2001 2004, was 24% higher than that of the 1979 - 1984. These results suggest that in the Sudano-Sahel Region, atmospheric dust loadings in recent years are generally higher than those of previous three decades. Further analyses to establish the relationship between AI and rainfall shows that rainfall decreases with an increasing TOMS Aerosol Index. It is further observed that the regions mean annual rainfall for 1971 2001 was 15.5% lower than the mean for 1940 1970. Decreasing trend of rainfall resulted in the southward shift of the isohyets and rapid encroachment of desertification from neighbouring country into this part of Nigeria. This is captured in the satellite imagery of NigerianSAT-1 that is also being used in this study. Socio-economic implications of this, is poor crop yields and acute food shortage in the region and attendant problem of migration of the indigenes who are mainly nomads down to the coastal region of the country.

Keywords: aerosol index variability, rainfall variability isohyets, satellite imagery

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JMS005 **Oral Presentation** **851**

Aerosol-cloud-precipitation interactions in orographic precipitation events

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Anthropogenic and natural aerosols serve as a source of cloud condensation nuclei (CCN) and influence the microphysical properties of clouds. An increase of the aerosol load leads to an increase of the cloud droplet number concentration and, for a given liquid water content, to a decrease of the average cloud droplet size. Since the collision efficiency is small for small droplets, the increased aerosol load induces a deceleration of the cloud drop coalescense process in warm-phase clouds which delays the conversion of cloud droplets into rain. In mixed-phase clouds the riming efficiency is reduced which may lead to a prolongation of the precipitation development. Thus, the aerosol-cloud-precipitation interactions may modify the mechanisms responsible for the precipitation formation which may then alter the surface precipitation budgets along the orography. In the case of low-level orographic clouds the aerosol-cloud-precipitation interactions are suspected to reduce the amount of upslope precipitation and to enhance the precipitation on the downslope side of mountains (Givati and Rosenfeld 2004, Borys et al. 2003}. The net effect may lead to a shift of the precipitation distribution towards the leeward side of mountains which affects the hydrological cycle on a local scale. The main purpose of this study is to investigate aerosol-cloud-precipitation interactions in mixed-phase orographic clouds for different dynamical situations. The aerosol indirect effect on the hydrological cycle will be quantified. Herefore, simulations of moist orographic flows over topography are conducted and the influence of aerosol particles on the orographic precipitation formation is analyzed by comparing a polluted case against a clean reference case. The degree of aerosol pollution is simulated by prescribing characteristic aerosol spectra which are then available for the nucleation processes. The simulations are performed with the nonhydrostatic weather prediction model LM (Doms and Schttler 2002, Steppeler et al. 2003) at a horizontal resolution of 2~km. In order to treat aerosol-cloud-precipitation interactions consistently the aerosol-microphysics and cloud-microphysics are coupled following a two-moment approach.

Keywords: aerosols, clouds, precipitation

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JMS005 **Oral Presentation** **852**

Classification of aerosol effects on precipitation

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It is widely accepted that aerosols affect cloud microphysics and precipitation. At the same time many results of both observations and numerical studies are controversial. In some studies a decrease in cloud intensity and precipitation (including the total precipitation depletion) with the increase in the aerosol concentration was reported. Other studies report convection invigoration, which however, leads to precipitation inhibition. There are also studies reporting both convective invigoration and an increase in the precipitation. According to some studies an increase in the aerosol concentration leads to the decrease in the amount of ice precipitation, other studies report the increase in the ice precipitation. Some studies do not show any aerosol effects on precipitation. Being considered without any classification, the results could be interpreted in the sense that aerosols effects are variable, contradictory and not clear from physical point of view. The utilization of numerical models that unable to simulate aerosol effects adequately increases the noise that creates additional difficulties in retrieval of useful signal. In the review an attempt is performed to classify aerosol effects both observed and simulated numerically. This classification is based on the analysis of water and heat budget of clouds developed under different aerosol and thermodynamical conditions. It is shown that aerosols increase both condensate production and the loss of precipitating mass. Aerosol effects on precipitation are determined by the relationship between two opposite aerosol effects. This relationship is shown to be dependent on the thermodynamic conditions and cloud types. Difference in the aerosol effects are illustrated using numerical results of simulation of maritime and continental shallow and deep convective clouds, mixed phase and winter orographic clouds and warm stratocumulus clouds.

Keywords: cloud aerosolinteraction, precipitation, heatandmisturebudgets

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Oral Presentation** **853**

The opposite effects of pollution aerosols on convective and orographic precipitation

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Reviewing the impact of smoke and pollution aerosols on clouds and precipitation according to physical consideration provides much better defined picture than portrayed by the IAPSAG report. The guiding physical factors have been already documented by various studies that will be referenced in the presentation. The factors that affect clouds through the CCN activity of the aerosols are: 1. The depth above cloud depth for onset of warm rain (DL) in convective clouds that feed from the boundary layer is determine by the CCN concentrations in a simple linear relation that appears to be similar in a wide range of environments. Therefore, some and pollution aerosols can shut off completely rain from shallow clouds with depth respective to the small CCN concentrations, up to cloud top temperature of about -10C, where mixed phase precipitation can form even in very polluted clouds. 2. Added small CCN that cause smaller supercooled cloud droplets reduce the rate of conversion of cloud water into ice hydrometeors for given liquid water content mainly due to the reduction in riming efficiency of the smaller drops. The combined effects of (1) and (2) explain the observed decrease in orographic enhancement factor of precipitation in areas where pollution aerosols have increased. This is so because orographic clouds are typically shallow and short living. 3. Polluting deep warm base maritime convective clouds prevents early rainout and lifts more cloud water to the supercooled levels, where that water freezes onto ice hydrometeors. The added release of latent heat of freezing aloft along with the added low level cooling when the ice hydrometeors melt means transferring upward more heat for the same amount of surface precipitation. This must result in greater conversion of static instability into kinetic energy and hence greater convective overturning for a given instability. 4. The amount of surface precipitation from deep convective clouds is a small difference between the two large terms of condensation minus evaporation of both cloud and hydrometeor particles. Therefore, adding condensates in (3) would add surface precipitation only if the evaporation losses are small, which requires moist environment. Therefore, polluting microphysically maritime clouds would almost always invigorate them, but will add surface precipitation in moist environment, and will decrease surface precipitation in dry environment. The addition of giant CCN works to reduce the impacts of the small CCN, but cannot com-pletely eliminate them. The radiative effects of absorbing aerosols intercept solar radiation from reaching the surface and energize deep convection. Very large amounts of absorbing aerosols (optical depth > 1) can eliminate altogether shallow clouds. For deep clouds this effect can dominate over the invigorating microphysical effect mentioned in (3) and suppress the vigor of the convection. Measured and simulated examples will be given to the manifestation of all these processes by references and will be presented to the extent allowed by available time for the presentation.

Keywords: cloud aerosol precipitation

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JMS005 **Oral Presentation** **854**

Effects from multiple species of insoluble aerosol particles on the glaciation and precipitation production of deep convective clouds in a tropical Atlantic hurricane

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Constantin Andronache

During July 2005, the Tropical Cloud Systems and Processes (TCSP) experiment was performed from San Jose, Costa Rica by NASA. The general mission of TCSP was to investigate the formation and evolution of tropical cyclones. Improved understanding of the mechanisms and effects of ice nucleation in deep convective clouds in a tropical cyclone has been an integral goal of the TCSP program because such clouds produce much of the ice for its upper-level cirrus outflow. An empirical parametrisation of heterogeneous ice nucleation has been formulated for application in cloud and large-scale atmospheric models. It represents dependencies on predicted mass concentrations for multiple chemical species of ice nucleus (IN) aerosols. The scheme includes condensation-, immersion- and contact-freezing modes, in addition to vapour deposition, as mechanisms for heterogeneous nucleation. These species of IN include mineral dust, black carbon and insoluble organic (e.g. biogenic) particles. Finally, the scheme represents the suppression of heterogeneous nucleation at low humidities and warm subzero temperatures seen in several laboratory studies. The present study presents numerical simulations with a microphysical model of deep convection observed in TCSP. Impacts of various chemical species of IN on the mechanisms for glaciation of deep convective clouds and of their outflow to cirrus are shown. Modification of precipitation production by altered IN loadings (e.g. in a desert dust episode) is discussed.

Keywords: dust, heterogeneous, ice

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JMS005 **Oral Presentation** **855**

Numerical simulations of microphysical processes in pyro-convective clouds

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Deep convection induced by vegetation fires plays an important role forthe transport of aerosol particles and trace gases into the upper tropospereand lower stratosphere. Additionally, due to the emission of a large numberof aerosol particels from forest fires, the microphysical structure of a pyroconvectivecloud is clearly different from that of ordinary convective clouds.To investigate the aerosol-precipitation-interaction in pyro-convective clouds weperform numerical simulations of idealized fires using the Active Tracer Highresolution Atmospheric Model (ATHAM) and an air parcel model with detailedcloud microphysics.Using different microphysical schemes within ATHAM and initializing theair parcel model from the full 3-dimensional model simulation, we investigatethe influence of the number concentration of aerosol particles on the formation ofcloud and rain droplets, their size distribution and transition to the ice phase.Based on the detailed cloud-parcel model, the results from the microphysicalschemes within ATHAM will be evaluated. The two-way interaction betweenthe dynamics of the pyro-convective clouds and the cloud microphysics will beexplored.

Keywords: pyro connvection, microphysics

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JMS005 **Oral Presentation** **856**

Aerosol-cloud-precipitation interplay: an observational study

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IAMAS

P. Ernest Raj, K.K. Dani, R.L. Bhawar, S.K. Saha, G. Pandithurai, S.M. Sonbawne

Atmospheric aerosols exhibit large temporal and spatial variations due to a variety of production, removal and transport processes. Although their interactions with solar and terrestrial radiation are known to some extent, the magnitude of these interactions is poorly constrained because of limited understanding of the processes that control the distributions. Certain aerosols act as cloud condensation nuclei (CCN) and ice nuclei (IN), and contribute to the cloud formation / development, and hence cloud cycling mechanisms modify aerosol properties in the troposphere. Thus, the study of their impact on clouds and precipitation has been a challenging problem. In addition, the impact of aerosols on weather and climate, satellite remote sensing, air and water quality has been the subject of numerous investigations. The aerosol-cloud-precipitation cycle is the major and not-clearly-understood mechanism responsible for the modification of aerosols in the troposphere, which leads to cloud growth and subsequent precipitation under favorable meteorological conditions. Some investigations made in this direction using the lidar, sun-sky radiometer and satellite observations are presented in this communication. Over 800 weekly-spaced vertical profiles of aerosol number density over Pune (an urban station in India) obtained from the bi-static Argon-ion lidar observations, spread over the 20-year period from 1987 through September 2006 have been used in this study. The aerosol column content has been computed by height integrating each vertical profile from 20 m to 1100 m. The concurrent weekly total rainfall data from the India Meteorological Department (IMD), Pune, and TOMS estimated Aerosol Index (AI) have been used in the study. Positive value of AI indicates absorbing aerosols and negative value indicates non- or less-absorbing (nearly scattering type) aerosols. The main results of the study indicate (i) greater concentration of sub-micron aerosol particles during the winter (December-February) and coarse-mode particles during the pre-monsoon (March-May), (ii) The year-to-year variation in the aerosol column content shows good correspondence with seasons total precipitation over the experimental station, (iii) The time series of AI shows bell-shape with maximum AI during pre-monsoon and minimum during winter, (iv) Dominance of absorbing aerosols during pre-monsoon and less-absorbing aerosols during winter, (v) Variation of AI is significantly larger and negative during 1987, 2002 (weak monsoon years) as compared that during 1988, 2004 (active monsoon years) and (vi) Both aerosol loading and total column precipitable water content are observed to be smaller during 1987, 2002 in contrast to that during 1988, 2004, and (vii) The association between the variations in AOD and temperature is noticed to be opposite during weak monsoon years. More details of the study and results will be presented.

Keywords: aerosolindex, precipitation, aerosolcolumncontent

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JMS005 **Oral Presentation** **857**

Ice formation by different aerosol types and implications for aerosol effects on mixed-phase clouds

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Ice initiation in clouds warmer than -35C is presently known to occur only through the action of ice nuclei. It is important to identify the action of different types of aerosol particles as ice nuclei to understand and constrain numerical predictions of their role in affecting cloud microphysics, cloud chemistry, precipitation and climate. Toward this end, this paper summarizes information we have obtained from a number of years of atmospheric sampling of ice nuclei and laboratory study of presumed realistic examples of atmospheric particles. Atmospheric measurements of ice nuclei concentrations, physical and chemical characteristics made by processing ambient aerosols and evaporated cloud particle residuals in a continuous flow diffusion chamber demonstrate the special nature of this population. Measured concentrations of ice nuclei (excluding contact-freezing nuclei) as a function of supercooled temperature and supersaturation are usually below 0.1 cm-3 under any conditions except in special circumstances. Ice nuclei concentrations measured in the free troposphere also do not follow an exponential increase with decreasing temperature, but rather increase only modestly at lower temperatures. Nevertheless, there is tremendous variability of ice nuclei concentrations even at one set of aerosol processing conditions that appears related to the concentrations of larger aerosol particles present. Analysis of the residual particles from freshly nucleated ice crystals formed in the continuous flow chamber identifies the majority of these larger particles as mineral dust particles. Nevertheless, a significant secondary contribution from carbonaceous particles is sometimes present. We have explored the action of realistic mineral dust particles and carbon-containing particles as CCN and ice nuclei in the laboratory. While the ice nucleating behavior of mineral dusts supports their strong and variable action in the atmosphere, the contribution of realistic black carbon-containing particles (including biomass burning particles) as ice nuclei appears far more selective and prohibitive. Finally, we briefly consider the potential of biogenic carbonaceous aerosols as atmospheric ice nuclei active at modest cloud supercooling.

Keywords: ice nuclei, aerosols, clouds

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Oral Presentation** **858**

The aerosol pollution-precipitation connection

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The International Aerosol/Pollution Assessment Group of IUGG/WMO, IAPSAG, has recently produced an extensive background Review on an issue of great importance to society and governments [Aerosol Pollution Impact on Precipitation: A Scientific Review, Prof. Zev Levin, Chairman IAPSAG, Prof. William Cotton, Vice Chairman]. It is time now for a quick critical discussion of the Report and the basis it has created for the planning of larger-scale, multifaceted field programs which directly address some relevant practical issues. As the representative of IUGG with WMO, I had proposed such an assessment to WMO Congress Cg XIV in 2003 because I sensed the importance on the mounting evidence in the literature of a possible decrease in rain in the presence of aerosol pollution. I also wanted to test the system and see if the IUGG, IAMAS and the Cloud Physics community have the capability to play a major role in the development/ execution/ evaluation of realistic and politically acceptable international projects of high scientific value - or if IAMAS should stay on the sideline and restrict itself to organizing scientific assemblies. The Cloud Physics community has also been staying on the sidelines for far too long, unable, for example, to make precipitation on of the key issues of climate change studies. For the sake of its students Cloud Physics has to become an exciting field dealing with big and real issues - not just details.

Keywords: aerosol, biomass burning, precipitation

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JMS005 **Oral Presentation** **859**

In-cloud Measurements of Absorbing Aerosols during the Marine Stratus Experiment, CA 2005 : What is their Mixing state and Climate Impact?

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The marine stratus experiment (MASE) field campaign, funded by the U.S. Department of Energy, was carried out in July 2005 off shore of the California coast. The aim of these measurements was to elucidate aerosol processes regulating marine stratus clouds. As part of the campaign, a photoacoustic aerosol spectrometer was deployed on the CIRPAS (Center for Interdisciplinary Remotely Piloted Aircraft Studies) Twin Otter aircraft. In addition to aerosol absorption the instrument is also capable of measuring total scattering through a collocated scattering sensor. During the campaign the aerosol absorption was often low and indistinguishable from instrumental noise (~0.6 Mm-1 for 2 minutes averages), indicating clean conditions. However, on July 6th 2005, during a flight off of the coast of Point Reyes, California, we sampled an interesting short-term in-cloud event with much higher absorption and scattering. The photoacoustic signals coincided with a large peak in the SO4 and total inorganic concentrations as measured by a PILS (Particle Into Liquid Sampler) and an AMS (Aerosol Mass Spectrometer), also on board the plane. Due to the inlet characteristics most of the aerosols sampled by the photoacoustic instrument were interstitial aerosols. PILS and AMS instead, were operating behind a counter-flow virtual impactor, therefore sampling only in-cloud-droplet aerosols. During this episode, our simultaneous measurements of absorption and scattering yielded an aerosol single scattering albedo (ratio of scattering to total extinction) of about 0.92 0.02. This single scattering albedo is consistent with a mixture of absorbing aerosol and sulfate in a volume ratio between ~1.5% and 15%, depending on the aerosol size distribution, complex index of refraction and mixing state. An analysis of the aerosol single scattering albedo vs. the cloud liquid water content suggests that sulfate and absorbing aerosols are internally mixed. For internally mixed aerosols the range of volume fractions needed to explain the observed single scattering albedo would be reduced to ~1.5% - 4.5%. The hydrophilic nature of the sulfate phase in an internally mixed aerosol enhances the probability of absorbing aerosol of being incorporated in cloud droplets. The absorbing phase of the aerosol then can contribute to the reduction of the cloud droplet albedo. Cloud albedo has a fundamental role in regulating the earth's radiative balance. For example a cloud albedo of 0.99 on a global scale yields a solar absorption forcing of 4.5 W m-2, while a cloud albedo of 0.999 for 10% of boundary layer clouds yields a forcing of ~0.045 W m-2 (Erlick and Ramaswamy, GRL, 2003). Furthermore, aerosol cloud scavenging and processing can significantly influence the lifetime and fate of aerosols in the atmosphere. We are currently using our observations to estimate the absorbing aerosol fraction in cloud droplets to quantify these possible impacts.

Keywords: climate, clouds, aerosols

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JMS005 **Oral Presentation** **860**

Potential Indirect Aerosol Effects in Cirrus Clouds: A New Perspective

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As measurements of the ice particle size distribution (PSD) and ice crystal shape improve, there is considerable evidence that the measured high concentrations (~ 1 cm-3) of small ice crystals (D < 60 m) in some cirrus are real and not an artifact due to the shattering of larger ice particles at the inlet of optical probes. For example, PSD exhibiting high concentrations of small ice crystals sometimes occur when the concentrations of larger ice particles (D > 300 m) are relatively insignificant or absent. The shapes of the small crystals generally appear quasi-spherical or compact (when large enough to resolve shape), and do not appear fragmented as one would expect from shattering events. Moreover, IR remote sensing techniques indicate high concentrations of small crystals. For temperatures warmer than -45 oC, the PSD generally appears quasi-bimodal with an inflection point around 60 µm denoting two ice particle populations differing in shape and size, based on measurements by the FSSP, the Cloud Particle Imager (CPI) and the 2DC probe. The large particle mode (D > 60 µm) appears as a shoulder appended to the small particle mode. The small mode had the following attributes: mean dimension (length) ranged from about 10 µm to 20 µm, ice water content (IWC) ranged from about 10% to 80% of the total IWC, and number concentration ranging from about 0.1 to 4.5 cm-3, based on a temperature range of -65 oC to -30 oC. We were interested in whether the observed attributes of the small and large modes of the PSD could be explained theoretically. Taking the view that the small mode crystal concentrations are not measurement artifacts, we postulate that most ice nucleation events proceed first through the liquid phase as haze or cloud droplets, with some subset of this population subsequently freezing to form quasi-spherical crystals. This would include heterogeneous nucleation at temperatures warmer than -35 oC. In an exploratory study using a mixed-phase parcel model, we investigated what type of mechanistic behavior could possibly explain the bimodality presumably observed in natural cirrus. For example, if these high concentrations of small compact ice crystals truly exist, why are there two distinct populations of ice particles in terms of PSD shape and crystal shape, and what physics are responsible for maintaining this bimodal structure? And how can we mechanistically account for the mean size, IWC and number concentration of the small crystal mode typically observed in cirrus? The parcel model developed treats the diffusional growth of ice crystals using mass- and area-dimension power law relationships. Ice crystal growth rates are based on observed crystal growth rates from laboratory wind tunnel (regulated updraft) experiments. The wind tunnel results were generalized for any supersaturation using Ficks First Law of Diffusion. It was found that part of the reason for the observed bimodal behavior was due to the fact that the small compact crystals have linear growth rates much less than branched crystals. But to explain all the bimodal attributes, a two-step nucleation process was needed. We assumed that the ice nuclei normally measured are a small subset of the total ice particle concentration, and that the small compact crystals result from the freezing of a small subset of the cloud droplet population. In step 1, the ice particles building the large mode nucleate first on traditional ice nuclei. In step 2, in cloudy regions with negligible updraft, the Bergeron-Findeisen process evaporates cloud droplets and a subset of these droplets freeze (possible mechanisms include the inside-out contact nucleation described by Shaw and Durran 2005). This produces a sudden burst of small quasi-spherical crystals and drops the supersaturation over ice to near-zero values, thus severely limiting further growth and locking in the bimodal structure. The mean size, fractional IWC and number concentration of the small mode that was typically observed was reproduced reasonably well, and shown to be sensitive to observed changes in

aerosol concentration. But this two-step mechanism does not account for the high ice crystal concentrations observed in cirrus containing no large ice particles. Therefore, if it occurs, there may be a simpler process that is also active that is yet to be revealed. The main purpose of this study is to show that processes may exist in cirrus clouds that can account for bimodal PSD, and that the small crystals may be nucleated from a subset of the cloud or haze droplet population. If that were true, then cirrus will have an indirect aerosol effect that primarily affects the small mode of the PSD. At temperatures less than -45 oC, the small mode appears to dominate the radiative properties of mid-latitude and tropical cirrus clouds. These clouds may be very sensitive to an indirect aerosol effect.

Keywords: cirrus clouds, nucleation

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JMS005 **Oral Presentation** **861**

Does air pollution suppress orographic precipitation in Israel?

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The effects of air pollution on precipitation have received a great deal of attention due to the importance of the subject to water supply and to climate. Recent paper by Givati and Rosenfeld (2004) reported that air pollution in both central and California reduced precipitation over the upslope side of the mountains as compared to the amounts falling upwind of the polluting urban centers. We took a second look at data from and found different results. In this study we analyzed rainfall data from the past 50 years and divided it based on geographical location, upwind of pollution centers along the coast and downwind of pollution centers on the upslope of the mountains. In general it we observe that the precipitation in both places increased. Furthermore, the ratio of the precipitation over the mountain divided by the precipitation over the coast (called the orographic ratio, R0) has generally remained the same. In some areas, especially in the central part of and downwind of the major urban polluted area of the country, R0 actually increased. This is in contrast to the rainfall suppression reported by Givati and Rosenfeld (2004). Moreover, the ratio of precipitation over the downwind side (on the eastern side of the mountain) to the amount on the upwind side (the western slopes) in the northern part of (the Galilee Mountains) has decreased, in contrast to the reports from the same area by Givati and Rosenfeld (2005). The possible reasons for the discrepancies between these results will be discussed.

Keywords: orographic, rainfall, pollution

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JMS005 **Oral Presentation** **862**

The influence of biomass burning aerosol on deep tropical convection; results from the active campaign

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During the winter of 2005/2006 detailed studies of aerosol and anvil microphysics were made in the HECTOR clouds forming over the TIWI islands in Northern Australia during the ACTIVE project. Measurements were made in the boundary layer and lower free troposphere using the NERC Dornier aircraft, whilst measurements in the convective cloud anvil were made using the ARA Egrett aircraft. Radar measurements of the cloud development and microphysics were made. During November and December 2005, prior to the onset of the monsoon, convection was dominated by isolated large storms (HECTOR) forming over the TIWI islands. These clouds were heavily influenced by smoke from Biomass burning. The origin of the smoke was mixed, with local burning on the Tiwi islands a main source, but also smoke advected over longer distances was often encountered in layers within the free troposphere. There was evidence that this material was mixed into the developing clouds. Detailed measurements of the aerosol size distribution and chemical composition were made, the latter with an aerodyne aerosol mass spectrometer and from the analysis of filter samples. During the monsoon period and during monsoon breaks after Christmas the clouds were not significantly influenced by biomass burning and aerosol loading s were much smaller. During the break periods the formation of rather similar HECTOR storms to the pre-monsoon period were observed. In this paper modelling studies of these clouds will be presented using a combination of a Cloud Resolving Model and an explicit microphysics model. Using these models the sensitivity of precipitation formation and anvil microphysics to the aerosol entering the cloud will be examined with a particular emphasis on the role of the aerosol from biomass burning. The role of these aerosol as both cloud condensation nuclei and ice nuclei (in competition with other particles found in the area) will be explored. The sensitivity to aerosol will be explored in the context of variations in the structure of the atmosphere in which the clouds form. The relative importance of the aerosol and the atmospheric structure were investigated. It is found that changes to the aerosol input can have a significant impact on the timing of precipitation from the cloud system; however, the impact on the total amount of precipitation was small. A very important effect was found to be the position in the cloud where latent heat of freezing was released. If a substantial amount of liquid water froze homogeneously then this was able to cause a substantial increase in the up draught close to the top of the cloud. This increased both the cloud top height and the ice mass in the anvil region. Hence there was an optimum number of both CCN and IN favouring maximum cloud development. Aspects of the vertical structure of the atmosphere in which the cloud formed substantially influenced the sensitivity of the cloud to the aerosol. For example, if dry layers were present this had a marked effect. The implications of the results for role of biomass burning aerosol in precipitation formation will be explored.

Keywords: bioaerosols, clouds, ice

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JMS005 **Oral Presentation** **863**

Interactions between pyrogenic aerosols, clouds and precipitation

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Atmospheric aerosols strongly affect climate in several ways, both through direct interaction of the aerosol with solar and terrestrial radiation, and via perturbations of cloud properties and convective dynamics. This presentation will outline these effects, emphasizing those related to cloud microphysics and precipitation. High loadings of smoke particles and pyrogenic trace gases are present during the burning season in the boundary layer over vast reaches of Amazonia. These smoke aerosols have pronounced effects on the radiation budget, cloud microphysics and precipitation formation, as shown by in-situ measurements and remote sensing data. These effects are likely to perturb convective dynamics, precipitation, and atmospheric composition on regional to global scales. Model studies of deep convection over large fires at higher latitudes also show strong perturbations of cloud microphysics and precipitation processes, resulting in stratospheric injection of biomass smoke. These model results are in good agreement with field observations.

Keywords: pyrogenic aerosols, clouds, precipitation

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JMS005 **Poster presentation** **864**

Evaluation of International policies for climate changes in mega cities to reduce GHG emissions through Clean Development Mechanism.

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The Urban population of developing countries is predicted to rise from one third in 1990 to over 50% by 2025. In 1950 the worlds total urban population was 734 million, of whom 448 million were living in developed countries and remaining 286 Millions were in developing region. By 1980, the worlds total urban population had increased to 1.8 billion of whom the majority, 958 million were living in developing countries. The corresponding figures for the year 2000 are expected to be 3.2 billion. On the basis of these figures and other global trends, it would appear that Africa and Asia will have the highest share of worlds urban growth in next 25 years, resulting consideration rise of large number of metropolitan cities. Over the next generation of greatest increase in population, in production and in poverty will occurs in cities causing the social, economic and environmental problems due to greenhouse gases in these cities. Due to this rapid urbanization and industrialization, the problems of Total suspended particles, sulfur dioxide(SO2),Nitrogen dioxide(NO2),ozone, Nitrogen Oxides(NOx), which often leads to formation of SO$ and NO3 aerosols, it would be necessary to study the process of clean development mechanism in view of increased energy demand, transport, industrial activity,biomass burning and waste generation due to urbanization. Measures are being taken by various countries to reduce the air pollution and greenhouse gas emissions using different policy instruments. This paper deals with evaluation of national and international policies adopted under Kyoto Protocol and other institutional frameworks for emission trading and CDM and its impacts on socio-economic development. The paper also discusses the successful introduction of control technologies in practice to reduce the Non CO2 Greenhouse gases in mega cities along with the social-economic and industrial policies and instruments.

Keywords: bio mass burning, aerosols, climate changes

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JMS005 **Poster presentation** **865**

Direct observations of daytime atmospheric boundary layer depth

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The daytime growth of atmospheric mixed layer is important in time variation of air pollution over big cities. The depth variations of this layer can be estimated from direct measurements and also from numerical forecast models if the model is properly calibrated. The depth of the daytime mixed layer for the city of Zanjan (48.5 N, 36.7 E, 1700 m) has been studied using a LIDAR (532nm) system, which works on aerosols scattering of laser light. The mixed layer depth (zi) for Zanjan city is found to be between1 km typically in spring to 3 km in summer for synoptic calm conditions. In entrainment zone, the observations show signs of K-H instability especially in cases with strong shear in this zone. Also the MM5 forecast model with a proper boundary layer scheme (MRF) is used to estimate (zi) which shows rather good agreement with direct observations using LIDAR system.

Keywords: mixedlayerdepth, lidar, mesoscalenumericalmodel

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JMS005 **Poster presentation** **866**

Polycyclic aromatic hydrocarbons (PAHs) in the atmosphere of Yinchuan city in Northwest China

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Three periods of January, April, July and October (that represents house heating period from November to March, ,spring-sandstorm period from March to May and no-house heating period from June to October in Yinchuan respectively) monitoring program for PAHs in the aerosol started on January 1989 was carried out in 7 specific areas including that is suburbs, traffic roads, residential areas, commercial centers, public parks, cultural & educational areas and industrial areas in Yinchuan, the capital city of Ningxia Hui Autonomous Region, to determine temporal variations of PAHs and their distribution in different specific areas and concentration of particle size-segregated PAHs. A total of 210 samples were collected and with the gas chromatographic spectrometer, Sigma10 data analyzer (made by US P-E company), Soxhlet extractor (500ml), K.D concentrator and etc, 6 PAHs species were identified, which are Phenanthrene(PHEN), Pyrene(PYR), Chrysene(CHR),Perylene(PER), Benzo[a]pyrene (Bap) and Benzfluorence(BFLU). The minimum detection amount is 1.2 10-12g. The recovery rate of benzo[a]perylene is between 87-93% with deviation coefficient 4.1%. The recovery rate of phenanthrene, perylene, benzo[a]fluorene, chrysene, and picene is above 86% with a deviation coefficient under 10%. Some useful conclusions have been reached: (1) It is documented that the concentration of PAHs is the highest in January, which mainly come from coal burning for house heating and vehicle emission, and lowest in July and October. The concentration of PAHs of the 7 specific areas are arranged in decreasing order, that is suburbs, traffic roads, residential areas, commercial centers, public parks, cultural & educational areas and industrial areas. (2) The concentration of BPC PAHs (BPC = Bap + CHR + PYR) is also the highest in January, and it makes up more than 50% of all the six species of PAHs detected. The PAHs concentration in 3 out of the 7 specific areas is the second high in April, they are arranged in decreasing order, that is traffic, suburb, industrial, residential, cultural & education, commercial, park. Strong wind, sand and dust storm frequently occurs in April, and constitutes the major air pollutants in local cycles, all together with vehicle emissions makes PAHs in traffic roads the highest in April. PAHs concentration is the lowest in July and October, their decreasing order is commercial, residential, industrial, traffic, cultural & educational. The PAHs concentration is the highest in commercial area in this period, its mainly cause is coal-burning for making native food in the street. There are no PAHs detected in the park in July & October. (3) Bap concentration is ranged from 6.05-29.55 ng/m3 in January, 3.23-13.70 ng/m3 in April, which is spring-sandstorm period, and 0.30-8.70 ng/m3 in July & October, which is no house heating period. Bap has been detected in 7 specific areas except suburb in July & October. The PHEN, PYR, BFLU and PER are higher in January and have been detected in each specific area, PHEN, PYR and CHR are not detected at cultural & educational area and park in July & October. BFLU is not detected at traffic, cultural & educational, park area, and PER is detected only in commercial and industrial area, CHR concentration is the highest among the 5 species without Bap. (4) More than 50% PAHs are sorbed in particles less than 2.5μm in diameter with little exceptions. (5) Concentration of PAHs is higher in Yinchuan than that in other places concerned in this paper, so great efforts should be made to improve air quality in this region.

Keywords: segregatedpahsconcentration, aerosol, yinchuan

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JMS005 **Poster presentation** **867**

Variation of Submicron Aerosol with Air Mass Pathway Observed at National Park Area of Gyeongju, Korea

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Particulate matters have been the air pollutant of major concern. In particular, submicron aerosol has not only a further effect on visibility impairment than fine particles but also may damage to human health. However physico-chemical characteristics of submicron aerosol are rarely studied in the national park area of Korea. The importance of aerosol in the national park area can be used to estimate the possibility of its regional or long-range transport. In order to investigate elemental composition of submicron aerosol, atmospheric aerosol monitoring was conducted at the national park area of Gyeongju. Size- resolved submicron aerosol was collected on filters using a PM1.0 cyclone sampler and a MOUDI sampler. In this study, size-resolved elemental composition of submicron aerosol was qualified and quantified by PIXE analysis using a Tandem van de Graaff proton accelerator. Impact of air mass pathway on characteristics of particulate matters was also analyzed in the end point of Gyeongju with backward trajectory results from HYSPLIT model. Physico-chemical characteristics of submicron aerosol were classified into soil related mineral species (Al, Si, Ca, Fe, and Ti), anthropogenic related heavy metal species (Cr, Mn, Ni, Cu, Zn, Br, and Pb), and aerosol acidity related element of S. The sum of mass concentration of Al to Pb elements analyzed from the PIXE method accounted for 33 ~ 45 % of submicron particle mass. The elemental characteristics of submicron aerosol measured at the national park area where there was not such a big local source represented dissimilar patterns among different air mass pathways.

Keywords: submicron aerosol, national park area, pixe

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JMS005 **Poster presentation** **868**

Dissolved organic nitrogen deposition on agricultural and urban environments in the Rio de Janeiro State, Brazil

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The concentration of dissolved organic nitrogen (DON) has been investigated on agricultural area during time of dry and rainy season. Dry and rainy seasons in the Rio de Janeiro State are to the periods May-October and November-April, which dry season shows an intense biomass burning in agricultural sites. Campos dos Goytacazes is a municipality and city located in the northern area of Rio de Janeiro State, Brazil and represents an agricultural area and developed extensive monoculture practices with state-of-the-art plantation and harvesting technologies, including those for sugar cane (Saccharum officinarum L.). Since the Alcohol Program was launched in 1976 for vehicle fuel production, Brazils' agro-business now owns 4.2 million hectares or about 25 % of the global sugar cane areas and is the major sugar cane producer in the world. Niteri city, an urban area located in the southeastern flank of Guanabara Bay, Atlantic Ocean has geographic location and complex relief (coastal mountains) contribute to make pollutant dispersion difficult in the metropolitan region of Rio de Janeiro and is affected by pollutants from local emissions and possibly by long-distance transport as well. Distance between sites is about 203 km. We have emphasized the attainment of information on bulk deposition which includes atmospheric particle flows generated for the forest fires and the microbiana degradation and dispersion of the effluent industrials of the processing of the one sugar cane, as well as analysis in rainwater. The harvest of the one sugar cane had been between July and October. Sample collection in agricultural region has started in July 2006 to and will last until June 2007 and urban region, samples were collected in April 2005 and ended in February 2006. March 2006 was exceptionally a dry month. The objective of this study is to determine concentrations of organic and inorganic N in aerosol and rainwater samples, the distribution of the species investigated and their seasonal variability in two different regions. The forms investigated include DON, urea, nitrate, and ammonium. High volume bomb and bulk deposition were used for the analysis of particulate matter and precipitation. Nitrate was analysed by ion chromatography and ammonium collorimetrically using the indophenols blue method. For determination of DON, reduced N was oxidized to nitrate by $K_2S_2O_8$ under alkaline conditions and high temperature. Urea was determined by reaction with diacetyl monoxime and thiosemiarbarzide. The average molar distributions of the investigated N forms were 23% DON, 20% NO_3^-, and 57% NH_4^+. On average, urea comprises about 23% of the DON in Niteri city. Agricultural region showed average molar distributions to 80% DON, 11% NO_3^-, and 9% NH_4^+ and urea about 1% of dissolved organic N. In conclusion, our results indicate probability of being influenced by anthropogenic activities, principally biomass burning in agricultural region. In addition, other associated pollutants, persistent organic pollutants -POP's, can contributed to elevated fraction of organic N and increasing N-deposition can result in negative impacts on tropical forest and coastal water ecosystems.

Keywords: organic nitrogen, rainwater, biomass burning

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JMS005 **Poster presentation** **869**

Black Carbon Mass Concentration in Rain and Snow During SUPRECIP 2: Northern California, Winter 2006

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Black carbon (BC) or soot particles are unique in the atmosphere, both as efficient absorbers of radiation at all wavelengths and as hydrophobic particles that are not as easily removed by precipitation as other aerosols. BC not only affects the climate as an atmospheric particle, but once deposited to ice and snow surfaces, it can change the albedo and melt rate of certain regions of the cryosphere. Thus removal rates of BC, as well as radiative affects on snow and ice must be quantified. This study presents the results from our laboratory calibration and evaluation of a filtration method for measuring BC mass concentration in water and its application to ambient measurements. Both thermal evolutions of carbon and light attenuation techniques are combined to yield reasonably accurate results (+/- 30%). Mass absorption efficiency of BC on a quartz fiber filter has been calibrated using laboratory-prepared standards of BC in pre-filtered nano-pure water. Optical measurements made simultaneously to EGA analysis quantify the change in attenuation of light by the filter as the BC is removed. Mass absorption efficiency at 550nm for water-filtered BC is 35 (+/- 5) m2 g-1, which is comparable to previous lab studies using the same BC source and similar filters. Using a series of filters during the filtration process, average combined filtration efficiency is 95 (+/- 5) %. This analysis method is applied to fresh snow samples collected at Lassen Volcano National Park, a relatively pristine site, and Central Sierra Snow Lab, downwind of Sacramento and San Francisco Bay Area pollution. The falling snow was melted by a heated collection funnel and then refrozen until analyzed. Both sites are located in the Sierra Nevada Mountains, CA. Rain water samples from the Northern California Coast were also analyzed for BC concentration to determine local BC vs. possible contributions from long-range transport. Ambient aerosol measurements provide information on local and boundary layer aerosol that may have been subjected to below cloud washout during each event. Collection took place throughout February, March, April, and May of 2006, during which time Northern California experienced record rain and snow fall. Preliminary data shows that BC concentrations at the Lassen Vol. Natl. Pk. were low during February and March, but increased during April and May, while concentrations were higher during all 4 months at the Central Sierra Snow Lab. This field study was conducted as part of the PIER (Public Interest Energy Research) program and SUPRECIP 2 (Suppression of Precipitation Experiment) funded by the California Energy Commission.

Keywords: soot, precipitation, snow

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JMS005 **Poster presentation** **870**

The role of small aerosols in the formation of large hail in convective clouds

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Deep convective clouds are simulated under different meteorological situations typical of Europe (Germany) and Amazon region (Brazil). It is shown that the increase in aerosol concentration leads to an increase in the liquid water content at upper levels and foster the formation of large hail. Simulation of 28.06.06 hail event in Germany (near Stuttgart) using bin microphysics cloud model of the Hebrew University showed the formation of the 3 cm diameter hail in case of high aerosol concentration and significantly smaller size hail particles in case of low aerosol concentration. Effects of aerosols on the hail formation are especially strong in deep convection clouds with warm cloud base. It is shown that while "smoky" clouds produce significant amount of hail, including large hail, "green-ocean" ocean clouds do not produce any significant amount of hail. It is shown that large hail increases the precipitation efficiency of clouds.

Keywords: aerosoleffects, hailformation, precipitation

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JMS005 **Poster presentation** **871**

A shift of precipitation from sea to the land caused by small aerosol particles

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The precipitation in the Eastern Mediterranean takes place during cold season, when SST is larger than the land surface temperature by 5-8 . This temperature difference leads to the formation of the land breeze like circulation which interacts with dominating westerlies and leads to an intense cloud formation over the sea a few kilometers from the coastal line. Numerical simulations performed using an accurate bin microphysics model developed in the Hebrew University of Jerusalem indicate that an increase in concentration of small aerosols leads to a delay in precipitation and to the formation of extra ice particles with low sedimentation velocity. This ice is advected by the background wind to the land. As a result, precipitation over the land increases at the expense of the precipitation over the sea. The spatial shift of the precipitation from the sea to the land can be as large as 60 km depending on the wind speed of the background flow. The increase in aerosol concentration may lead to increase in the precipitation amount over the land by about 15 %-20 %. The possibility of the increase in precipitation by cloud seeding with small aerosols is discussed.

Keywords: aerosoleffects, breezecirculation, spatialprecipitationshift

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JMS005 **Poster presentation** **872**

Drizzle formation in stratocumulus clouds

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Formation of drizzling and non drizzling stratocumulus clouds observed during the field experiment DYCOMS-II is reproduced using a novel trajectory ensemble model of the boundary layer (BL). The computational area is fully covered by 1000-2000 Largangian air parcels with characteristic linear size of about 40-50 m. Since the parcels are adjacent, drizzle forming in one parcel can fall through the parcels located below and grow by collection of small droplets. It is shown that the model reproduces well the microphysical structure of both non-drizzling and drizzling clouds. It is shown that drizzle forms in a comparatively small number of lucky parcels located near the cloud top and having the widest droplet size distributions. The history of these lucky parcels is investigated by analyzing the values of supersaturation, vertical velocity, droplet concentration, etc. along the parcel trajectories. Simulations indicate that drizzle formation and rain flux in the stratocumulus clouds dramatically sensitive to the aerosol concentration. An increase in the aerosol concentration by factor of 3 can fully prevent drizzle formation. The physical mechanism leading to such high sensitivity is investigated. It is shown that the increase in aerosol concentration decreases droplet size and dramatically increases the rate of droplet evaporation. Therefore, small droplets do not reach the surface even in comparatively strong downdrafts. Application of the results to remote sensing problems is discussed.

Keywords: drizzleformation, cloud aerosolinteraction, remotesensing

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JMS005 **Poster presentation** **873**

Retrieval of LWC in stratocumulus clouds using two mode representation of drop size distribution

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Drop size distributions in a stratocumulus clouds are approximated by two narrow (actually delta functions) modes representing cloud droplets and drizzle, respectively. Detailed comparison with in-situ measurements, as well as with the results obtained using an microphysical cloud topped model of the boundary layer indicates that such representation allows one to accurately describe the main microphysical cloud properties, such as the mean and effective radii, LWC, radar reflectivity, Z-LWC relationships, etc. The two mode DSD are described by four parameters: the mean radii and drop concentration of each mode. Remote measurements of any four parameters, e.g., effective radius, extinction coefficient, radar reflectivity and Doppler velocity (mean sedimentation velocity of drizzle) allow one to calculate parameters of the two mode DSD and, therefore, to calculate liquid water content, drizzle flux, etc. It is shown that the two-mode representation of DSD is much more efficient in different retrievals than the traditional gamma- or exponential size distributions.

Keywords: drizzleformation, dropletsizedistributionrepres, remotesensing

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JMS005 **Poster presentation** **874**

Effect of air pollution on the precipitation in Eastern Georgia

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The sensitivity of daily variations of solid (graupel, hail) and liquid (rain) precipitations to the changeability of the air pollution is studied. For this purpose we carried out the analysis of the data about precipitations in Kakheti region during the week-days and weekends. Data of network more than 100 points of the measurements of hail and rain were used. The stations were located at a distance 60 80 km to east from the powerful source of an anthropogenic pollution of the atmosphere, from city Tbilisi. The data of a warm season (1964-1966) were analyzed, when the general level of atmosphere's pollution was much lower than in present. For each day the average to one measuring instrument sum of liquid (L) and solid (S) precipitation was calculated. There were 216 cases of measurement, including 166 during the week-days and 50 during the weekends. The estimation of difference between the investigated parameters was evaluated according to Students criterion with significance level not worse than 0.1. In particular the following results are obtained. As a whole average value of L was 13.68 mm and changed from 0.05 mm to 49.8 mm, average value of S was 2 mm and changed from 0.05 mm to 18.4 mm. The values of L during the week-days comprise: min 0.05 mm, max 49.8 mm, average 15 mm. For the weekends the average value of liquid precipitations was equal 9.37 mm and varied from 0.05 mm to 46 mm. The values of S during the week-days comprise: min 0.05 mm, max 18.4 mm, average 2.28 mm. For the weekends the average value of solid precipitations was equal 1.04 mm and varied from 0.05 mm to 6 mm. Thus daily sum of liquid precipitation during the week-days was higher than sum of precipitation during the weekends approximately 1.6 times. Daily sum of solid precipitation during the week-days was higher than this quantity during the weekends 2.2 times. The sum of liquid and solid precipitation during the week-days was approximately 1.65 times higher than during the weekends. The analysis of the data about the intensity of hail damages in the same region showed that the analogous effect was observed also in the middle of the eightieth years of past century.

Keywords: air pollution, precipitation

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JMS005 **Poster presentation** **875**

Saharan dusts suppress deep convection and precipitation

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Dusts are a significant climate forcing due to their direct effects on scattering and absorption of solar and thermal radiation as well as indirect effects on clouds and precipitation. There are inconsistent results of aerosol indirect effects on clouds and lack of direct evidence that reveal the impacts of dusts on rainfall internal structures. We utilize multi-sensors on multi-platforms to investigate Saharan dust layer impact on cloud and precipitation over Atlantic Ocean, with focusing on microphysical processes of dust-cloud interaction. We found that dusts transported up by the strong convection updraft acted as additional ice nuclei. Consequences of microphysical effects of dusts were shifting precipitation size spectrum from heavy precipitation to light precipitation and suppressing precipitation. Dusts also enhanced evaporation processes, which further reduced the precipitation reaching surfaces. Microphysical processes of dust-cloud interaction impact on water phase changes, reducing latent heating and cooling rates in both convective and stratiform regions. These microphysical processes of dust-cloud interaction had strong feedbacks to cloud thermodynamics and altered the vertical gradient of heating profiles in both convective and stratiform regions. Cloud system adjusted itself to these changes and resulted in a weak but long lasting cloud system with increasing convective precipitation fraction and decreasing stratiform precipitation fraction.

Keywords: dust, precipitation, clouds

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JMS005 **Poster presentation** **876**

The estimation of the impact of biomass burining over China by using a one-way nested global/regional chemical transport model system

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Masanori Niwano, Yu Liu, Pakpong Pochanart, Yugo Kanaya, Zifa Wang, Masaaki Takahashi

A one-way nested global/regional chemistry-transport model (CTM) system has been developed for the post-analysis of ground-based observation at Taishan (36.25N, 117.10E) in the North China Plain. This model system consists of the global CTM part and the regional CTM part. The global CTM part is based on CHASER with a horizontal grid spacing of about 2.8 degree. The regional CTM part is based on WRF/Chem. In the regional CTM part, the horizontal resolutions of three domains are 81km, 27km, and 9 km, respectively. The timing and horizontal distribution of biomass burning is estimated by using hotspot data observed by AATSR on ENVISAT. The peak height of biomass burning plume is assumed to be 400m, and the duration of each hotspot was assumed to be 4 days. To evaluate the impact of biomass burning, two model calculations (with and without biomass burning, respectively) have been executed. By considering the emission of precursor hydrocarbons from biomass burning, the episodic increase of ozone was well reproduced in the model on 4, 12, and 19 June 2006. The maximum increase of ozone by biomass burning was estimated to be 30 ppbv.Detailed results will be presented during the meeting.

Keywords: model, asia, ozone

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JMS005 **Poster presentation** **877**

Numerical study of the impact of aerosols on microphysics and dynamics of mixed-phase convective clouds

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Boryana Tsenova

Numerical simulations were carried out to investigate the effect of aerosols (CCN) on cloud dynamics, microphysics and precipitation of mixed-phase convective clouds. Several different in power convective clouds were simulated by 1-D bulk-water microphysical model. It was assumed that the differences between concentration and size of cloud condensation nuclei can be represented in the model by employing different rates and thresholds of conversion of cloud droplets to raindrops. The simulations reveal that the updraft velocity and cloud top height in some of the simulated clouds increase when the conversion rate of cloud to rain drops is higher, while in others is vice versa. The analyses of the results indicate that there is an increase in the precipitation in simulated convective clouds with fewer and bigger CCN although a different response of cloud dynamic to CCN is observed. The detailed analyses of the changes (due to CCN impact) of microphysical properties as a function of time and height in the simulated convective clouds will be presented and discussed.

Keywords: aerosols, numerical model, cloud microphysics

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JMS005 **Poster presentation** **878**

Effect of Aerosols on Precipitation and Climate over the Indo-Gangetic Plains

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Anup K. Prasad

The formation of dense haze, fog and smog over the Indo-Gangetic (IG) plains, a recent winter season phenomena since last one decade, affects millions of people. Recent studies have shown the effect of increasing aerosol loading and pollution on agricultural crops, vegetation, hydrological cycle and climatic conditions in the IG plains. In the present paper, we show the spatial distribution of aerosols parameters from MODIS, MISR, TOMS and OMI AURA satellites. The aerosols parameters are found to be highly variable in space and time and the nature of these parameters reflect the characteristics of the aerosol sources. The aerosols characteristics over the eastern part differ from the western part of the IG plains. In the eastern part, the sources of aerosols are mainly from coal based power plants whereas in the western part the aerosols sources are due to forest fire and biomass burning. The eastern part of the IG plains are affected by the number of dust storms every year which affect the atmospheric moisture regime over the IG plains. The aerosols characteristics show contrast influence on the precipitation and formation of dense haze and smog over the IG plains. The increasing trend of aerosols are found to show one to one relation with the increasing precipitation in some part and in other part it shows negative relation. Such contrast variations in precipitation will be discussed in the light of aerosol and cloud parameters.

Keywords: aerosls, precipitation, india

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Poster presentation** **879**

Semi-direct and -indirect effects of marine stratocumulus clouds

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In a newly developed bin resolved microphysics LEM model (BR-LEM),we have investigated the role of the microphysical response of stratocumulus clouds to the effects of absorbing aerosols. Included in the study are both precipitating and non-precipitating Sc clouds. Resultswill be presentedillustrating the effects of absorbing aerosols on the cloud microphysics. Wehave identified important impacts of the absorbing aerosol on these clouds as illustratedby the impact on the diurnal cycle of IWP and effective radius of the clouds compared to control runs. The origin of these impacts have been traced to the absorbing aerosol warming influences on the RH and changes to the cloud top entrainment.A contrasting influence of absorbing aerosol for precipitating and non-precipitating Sc will be discussed both from a microphysical and radiative forcing perspective.

Keywords: semi direct, bc, diurnal

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Poster presentation** **880**

High-altitude aerosol optical, microphysical and radiative characteristics at Sinhgad, India

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Measurements over high-altitude stations yield background levels of aerosol concentration. Added, these stations generally lie in the boundary layer during daytime and in the free troposphere during the nighttime, thus provide unique opportunity to investigate the transport/mixing of aerosols and gases from / between the boundary layer to / and the free troposphere. There is lack of knowledge about the distribution of aerosols and gases in the free troposphere in the tropical zone one of the less studied region of the planet. Moreover, under seasonally varying wind patterns, high-altitude stations, being in the free troposphere during night, become very important for regional study of pollutants, particularly during early morning / night transition period. In order to address some of these issues, extensive observations of aerosol optical, microphysical and radiative parameters have been carried out at Sinhgad, a high-altitude rural background station, situated on a hill-top with flat terrain, about 40 km by road, to the south-west of Pune during winter of 2006-07. This particular period was chosen for studying also the interesting phenomenon of haze in and around this site. A suite of instruments consisting of multi-channel CIMEL sun-sky radiometer; MICROTOPS II sun-photometer, ozonometer; Kipp & Zonen short-wave pyranometer and several aerosol direct sampling instruments including GRIMM real-time aerosol spectrometer and McGee aethalometer have been deployed in the study. Simultaneous measurements using these facilities have been made on some selected experimental days during December 2006-January 2007. The results of the study indicate column aerosol optical depth (AOD) of about 0.17 at 440 nm, water vapor of about 0.57 cm, and more cooling at surface (-52 W m -2) as well as at the top-of-the-atmosphere (-37 W m -2), which represent typical characteristics of high-altitude station of the type under study, and they are found to be very smaller as compared to those observed over an urban station like Pune. The results also show an association between radiometer-derived AOD and size distribution and surface-level black carbon concentration and meteorological parameters. The aerosol size distribution derived from direct as well as remote sensing methods have been examined in conjunction with HYSPLIT model back trajectories to understand the long-range transport of aerosols and pre-cursor gases, particularly during the periods of haze. The details of the complete observational program, experimental facilities deployed and more interesting results obtained will be presented.

Keywords: aerosols, radiometer, forcing

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Poster presentation** **881**

Impact of carbon activation on a Stratus Deck: Does aerosol number matter more than type?

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Simulations using a new cloud-resolving model which tracks both aerosols and cloud drops stochastically in a Lagrangian framework are used to investigate how different aerosol characteristics and activation mechanisms influence cloud properties. Results of different activation mechanisms that treat condensational growth on both soluble and insoluble aerosols are compared. This allows us to assess the impacts of black carbon aerosols, which can be insoluble and hydrophobic when freshly emitted, but can mix with water-soluble aerosols such as ammonium sulfate in the atmosphere. Our model reproduces the mean stratus cloud fields observed during the DYACOMS-II campaign. Simulations as a function of aerosol perturbation and activation mechanisms show that aerosol number is more important than aerosol type in determining key cloud quantities, consistent with recent observations.

Keywords: clouds, aerosol, climate

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS005 **Poster presentation** **882**

Properties of biomass burning aerosols in Brazil

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Paulo Artaxo, Plnio B. Camargo, Theotonio Pauliquevis, Luiz A. Martinelli

The influences of biomass burning emissions in the composition of aerosol have been studied in several sites in , in Amazon, Atlantic Forest and Southeastern Brazil . Inhalable particles, separated in PM2.5 and coarse particulate mode (CPM, with size in the range (2.5<dp<10 m)), were sampled in sites under influence of biomass burning and also in undisturbed sites and analyzed for BC, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, Rb, Sr, Zr, Pb. The average concentrations of PM2.5, CPM, BC and chemical elements were statistically higher in the dry season than in the wet season. The results of absolute principal component analysis showed four and three different sources for PM2.5 and CPM, respectively. Biomass burning is the main source of PM2.5 representing 60% of PM2.5, soil dust accounted for 14%, and industries and oil combustion contributed with 12% each one. Resuspended soil is the main source of CPM followed by industrial emissions and sugar-cane burning. The sampling and analytical procedures applied in this study showed that biomass burning and agricultural practices are the main source of inhalable particles, possibly altering the aerosol composition around these biomass burning sites in Amazon as well as in Southern Brazil .

Keywords: aerosols properties, biomass burning, brazil

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS006 **883 - 892**

Symposium
Glacial-Interglacial Cycles: New Records, Analyses, and Modelling

Convener : Dr. Valrie Masson-Delmotte
Co-Convener : Dr. Barbara Stenni

Water stable isotopes in snow and ice are precious tools to reconstruct past climatic changes; they can be also implemented into atmospheric, oceanic and ice sheet models. We encourage contributions showing new isotopic records from both precipitation and ice in polar and high altitude regions, as well as contributions showing new modeling results and interpretations of precipitation isotopic composition

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JMS006 **Oral Presentation** **883**

Polyphony of the multiscale climatic variations during the Pliocene/Pleistocene

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It is well known that the climatic variations are of very complex shapes. They are multiscale, apparently chaotic, and integrally nonstationary in the scale of the overall length of almost every paleoclimatic record being considered. Moreover a general trend seems to be existing in the largest scales of many Millions years. This trend probably is induced by the general evolution of the Earth planet and the Solar system as a whole. According to the modern mathematical nonlinear dynamical systems theory one can suppose that the shortest-term (the interannual and interdecadal) climatic variations reveal themselves as essentially nonlinear and apparently chaotic responses of the climate system to the different external forces (to the annual periodic heating of the climate system from the Sun mainly). Some more low-frequency (the centennial and millennial) variations can be of a quasi-linear character like oceanic and atmospheric tides. Usually they are of neutral stability, and so nonchaotic in principle. At last, the climatic variations of the supra-long scales can be more or less direct responses to the slowly varying external forces like the famous Milankovitchs orbital cycles. Studying such complex climatic variations is a great challenge for the international community of paleoclimatologists. A new technique of the wavelet and cross-wavelet analysis has been developed in order to clear up the essence of such paleoclimatic variations. This technique is applied to proxy (oceanic bottom and ice cores) climatic records covering the Pliocene/Pleistocene time period. As results, many evidences of nonlinearity and fingerprint of different external forces were obtained such as amplitude and frequency modulations of the paleoclimatic variations within a very wide range of time scales up to the scale of several million years. The well-known 100-kyr problem seems to be solvable by means of modeling the coupled polar and near-equatorial paleoclimatic variations as forced by the Milankovitchs orbital cycle insolations. In particular, the equatorial variations look to be quasi-linear responses to the Milankovitchs eccentricity and obliquity. In sum, paleoclimatic variations reveal themselves as a mutually ordered and self-adjusted complexity like Polyphony of musical chords.

Keywords: nonlinearity climate dynamics, chaos and order, wavelet analysis

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JMS006 **Oral Presentation** **884**

Quasi-100ky glacial-interglacial cycles triggered by subglacial burial carbon release

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A new mechanism is proposed in which climate, carbon cycle and icesheets interact with each other to produce a feedback that can produce quasi-100ky glacial-interglacial cycles. A central process is the burial and preservation of organic carbon by icesheets which contributes to the observed glacial-interglacial CO2 change. Allowing carbon cycle to interact with physical climate, here I further hypothesize that the switch from glacial maximum to deglaciation can be triggered by the ejection of glacial burial carbon when icesheets grow to sufficiently large size and subglacial transport becomes significant. Glacial inception may be initiated by CO2 drawdown due to a 'relaxation' from a high but transient interglacial CO2 value as the land-originated CO2 invades into deep ocean via thermohaline circulation and CaCO2 compensation. Also important for glacial inception may be the CO2 uptake by vegetation and soil regrowth in the previously ice-covered Boreal regions. When tested in a fully coupled Earth system model with comprehensive carbon cycle components and semi-empirical physical climate components, it produced under certain parameter regimes self-sustaining glacial-interglacial cycles with durations of 93 ky, CO2 changes of 90 ppmv, temperature changes of 6C. Since the 100 ky cycles can not be easily explained by the weak Milankovitch astronomical forcing alone, this carbon-climate-icesheet mechanism provides a strong feedback that could interact with external forcings to produce the major observed Quaternary climatic variations. In particular, some terminations maybe triggered by this internal feedback while others by orbital forcing.

Keywords: glacial, carbon, climate

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JMS006 **Oral Presentation** **885**

Investigating the climate-cryosphere interactions with the CLIMBER model coupled to northern and southern hemisphere ice sheet models

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A climate system model of intermediate complexity, coupled with Northern and Southern hemispheres ice-sheet models, was used to investigate the behavior and dynamics of past ice sheets for a complete glacial-interglacial cycle. The study of past ice sheets is extremely important to better understand the climate system as a whole, since they considerably interfere with both atmospheric and oceanic circulation and have a direct impact on sea level. The presence (or absence) of important ice sheets influences a wide range of variables, from runoff patterns to vegetation distribution. At the LSCE we dispose of a 2.5-dimensional climate system model of intermediate complexity, called CLIMBER, coupled with two different 3-dimensional thermo-mechanical ice sheet models; these two models are used to investigate respectively the Northern hemisphere (GREMLINS) and the Southern hemisphere (GRISLI). The CLIMBER model consists of various modules, interacting with each other through the fluxes of momentum, energy and water. The model has a coarse spatial resolution and a fast turnover time, which allows to extend climate simulations over periods of tens and even hundreds of thousands years. On the contrary, the GREMLINS and GRISLI models, have higher spatial resolutions of respectively 45 km x 45 km and 40 km x 40 km. The resulting coupled model describes satisfactorily the interactions existing between atmosphere, ocean, cryosphere and biosphere, as well as their evolution over various time intervals. The purpose of the study is to simulate the last glaciation and deglaciation events, from 126 kyr B.P. to present time. Such experiments have been forced by insolation (Berger, 1978) and atmospheric CO2 concentration inferred from experimental data (Petit et al., 1999). A set of sensitivity experiments has been carried out to test the relative importance of both external forcing factors and internal processes in triggering glaciation and deglaciation events. We strongly focused on investigating climate-cryosphere interactions in the Northern hemisphere, where it appears that the Laurentide ice sheet has a different timing compared to the Fennoscandian ice sheet, both for glaciation and deglaciation. In addition, the two major Northern ice sheets do not seem to respond with the same sensitivity to atmospheric CO2 concentration. References Charbit et al (2005) Investigating the mechanisms leading to the deglaciation of past continental northern hemisphere ice sheets with the CLIMBER-GREMLINS coupled model, Global and Planetary Change, 48, 253-273 Ritz et al (2001) Modelling the evolution of Antarctic ice sheet over the last 420,000 years: Implications for altitude changes in the Vostok region, Journal of Geophysical Research, Vol. 106, no D23, 31,943-31,964 Petoukhov et al (2000) CLIMBER-2 : A climate system model of intermediate complexity, Climate Dynamics, 16, 1-17 and Climate Dynamics, 17, 735-751 Petit, J-R. et al. (1999) Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica, Nature, 399, 429-436. Ritz et al. (1997) Sensitivity of a Greenland ice sheet model to ice flow and ablation parameters: consequences for the evolution through the last climatic cycle, Climate Dynamics, 13, 11-24 Berger A. (1978) Long-term variations of daily insolation and quaternary climatic changes, Journal of Atmospheric Sciences, 35, 2362-2367.

Keywords: modelling studies, ice sheets, glaciation deglaciation

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JMS006 **Oral Presentation** **886**

Simulation of glacial cycles with a climate-ice sheet model of intermediate complexity

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Simulations of the last four glacial cycles were performed with the coupled climate-ice sheet model of intermediate complexity CLIMBER-2 using the orbital variations and greenhouse gases concentrations as prescribed forcings. The model reproduces a number of important aspects of glacial climate variability both on orbital and millennial time scales, including dominating 100-kyr cycle and numerous abrupt climate changes resembling in temporal and spatial dynamics Dansgaard-Oeschger and Heinrich events. The role of dust-snow albedo and CO2 feedbacks are studied in a suite of sensitivity experiments. Results of model simulations also help to explain some phase relationships between different climate proxies seen in paleoclimate record. Overall, our modeling results suggest that a considerable portion of glacial climate variability arises from the direct and strongly nonlinear response of the northern hemisphere ice sheets to the variations in Earths orbital parameters amplified by a number of positive feedbacks and an intrinsic instability of the Atlantic thermohaline circulations and the ice sheets.

Keywords: climate, modeling, feedback

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JMS006 **Oral Presentation** **887**

EPICA Dome C glacial-interglacial variability

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Multiple climate proxies have been measured on the EPICA Dome C ice core. In this presentation, we compare the Antarctic temperature fluctuations reconstructed from the stable isotope composition of the ice to other climate indices available on the same ice core (flux of dust, chemical composition of the ice, greenhouse gas records) and highlight the advantages and limitations of each proxy records regarding past climate variability. We specifically focus on the comparison of trends and variability archived for the different interglacial periods. Finally, we discuss the relationships between orbital forcing, greenhouse gas concentration and changes in Antarctic temperature using both statistical analysis of the data, radiative transfer modelling and outputs from climate models.

Keywords: ice core, climate, glacial interglacial

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JMS006 **Oral Presentation** **888**

A 800 KY deuterium excess record from the epica dome C Ice core

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Enricomaria Selmo, Valerie Masson-Delmotte, Jean Jouzel, Martina Braida, Olivier Cattani, Sonia Falourd, Paola Iacumin, Sigfus J. Johnsen

Ice core records are one of the most valuable tools for reconstruction of past climate variations. Paleotemperature reconstructions from ice cores are based on the empirical relationships existing between either D/H or 18O /16O and condensation temperatures. Furthermore, the deuterium excess, d = deltaD 8*delta18O, contains information about climate conditions prevailing in the source regions of precipitation. In the framework of the European Project for Ice Coring in Antarctica (EPICA), two deep ice cores were recovered: one in the Dronning Maud Land Area (Kohnen Station), facing the Atlantic Ocean and the other at Dome C, facing the Indian Ocean. We focus here on the EPICA Dome C ice core (750604S, 1232052E, elevation 3233 m a.s.l., mean annual surface temperature, -54.5C, accumulation rate 25.0 kg m-2 yr-1) which provides a climatic reconstruction of the last 800 ky BP. The full length of the ice core (3260 m) have been analysed for both delta18O and deltaD values providing a new high resolution deuterium excess record. The delta18O and deltaD were measured in Italy and France, respectively, on a continuous basis of 55 cm (bag samples). The bag sample represents a mean temporal resolution of about 20 yr for the Holocene, 50 yr for the last glacial period, 200 yr for MIS 11 and up to 500 yr for previous warm stages. The deuterium excess values range between 3 and 14 with a mean value of 8.6. A general anticorrelation between d and deltaD is observed on the long term. High d values are found during the last part of interglacial periods and glacial inceptions while lower values characterize the glacial ones. The low frequency deuterium excess variability appears to be strongly influenced by obliquity fluctuations which are expected to alter the meridional temperature gradient between low and high latitudes. Our strategy is to combine the information from deuterium and deuterium excess data to reconstruct on a common time scale past changes in Dome Concordia surface temperature (Tsite) and ocean moisture source temperature (Tsource, mainly the sub-Antarctic Indian Ocean). We develop an inversion of the EPICA Dome C snow and ice isotopic composition using a simple isotopic model. Moreover, the glacial-interglacial change in moisture source conditions seems to have a limited impact on the temperature interpretation of Antarctic ice core records, with only a higher effect at the glacial inceptions.

Keywords: ice core, deuterium excess, antarctica

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JMS006 **Oral Presentation** **889**

Stable water isotope post-depositional evolution in snow of Central Antarctic and its possible influence on paleo-climate ice core interpretation

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Vladimir Lipenkov, Sergey Sokratov

Ice cores stable water isotopes data are powerful and widely recognized tool for paleo-temperature studies in polar regions. Moreover, the data from polar glaciers and ice sheets are often used as the etalon of past climate variability reconstruction. Despite some uncertainty in the absolute values of the past temperatures as given by the isotopic method, the evolution of climate, as presented by the shapes and the amplitudes of stable isotopes profiles, is believed to be well reproduced. There is, however, growing number of evidence that an initial climatic signal corresponding to the isotopic composition of snow precipitation can be significantly altered, or even erased, during snow deposition on the surface of the Antarctic ice sheet, as well as during considerable time period after the snow is already buried. First reason for such change is associated with the so-called relief-related noise, produced by uneven snow deposition on the undulating snow surface. The second reason can be the diffusive isotope smoothing, leading to weakening or erasing the short-term fluctuations in vertical isotopic profiles. The third reason, which is less studied but is closely linked to the two processes listed above, is the post-depositional isotopic changes due to mass exchange between the ice matrix surface and the moist atmospheric/pore air. The latter includes combination of the mass balance between the snow surface and the atmosphere and the diffusional transfer and phase transitions inside snow and firn.In this work we overview the available published information on the theoretical, modeling and laboratory experimental data on the stable isotopes post-depositional evolution in snow, and present field experimental data from Vostok Station. We also give a preliminary estimation of the influence of these post-deposition effects on the ice-core data interpretation. We suggest that maximum correction to the isotope-temperature paleo-reconstruction could be as large as about 20%. We also note that the post-depositional changes in isotopic content affect not only the amplitude, but also the shape of the ice core isotopic signal.This work is carried out in the frames of the Project 4 of Russian FTP Antarctica, with financial support from Russian Foundation for Basic Research grants 05-05-66803and05-05-39011. The A.E.s stay at ILTS is supported by the Japanese Society for Promotion of Science.

Keywords: paleo climate, ice cores, stable water isotopes

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS006 **Oral Presentation** **890**

Consistent paleo-temperature reconstructions from isotopic method and borehole thermometry at Antarctic Vostok Station

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The most common way of paleo-temperature interpretation of ice core isotopic data is a direct apply of the present-day geographical isotope-temperature relationship (confirmed by simple isotope modeling) to the isotopic variability in the remote past in a given point (Petit et al., 1999). It has been repeatedly noted, however, that this classical isotopic method underestimates the past temperature variations by 30-50% (Jouzel et al., 1997, 2003). Possible reasons for this are: influence of moisture source conditions; not clear effective condensation temperature; characteristics other than temperature affecting isotopic composition; change in precipitation seasonality; non-climatic (stratigraphic, relief-related etc.) noise occurring in vertical isotopic profiles; alteration of isotopic signal due to diffusive smoothing and other post-depositional processes, etc. One of the most reliable alternative approaches of paleotemperature reconstructions is a precise borehole thermometry followed by ice sheet dynamics modeling aiming to convert the measured vertical temperature profile into a temperature history (Salamatin, 2000, Tsyganova and Salamatin, 2006). For some computational runs, the estimates of Vostok paleotemperature amplitudes by isotopic and borehole thermometry methods varied by a factor of 2. Recently, the latter approach was substantially advanced by involving 2D Vostok ice flow-line modeling (Tsyganova and Salamatin, 2004). At the same time new improved version of simple isotope model has been suggested (Salamatin et al., 2004). The results of Vostok paleotemperature reconstructions by the both refined methods have turned to be essentially the same, showing the Last Glacial Maximum Holocene surface air temperature transition of about 12C. We also should note the difficulty in comparing the two methods, since simple isotope modeling produces condensation temperature that has to be transformed to the surface air temperature, while borehole thermometry deals with the effective ice sheet surface temperature. The latter is not necessarily equal to the surface air temperature, too (Lipenkov et al., 2004). This work is carried out in frames of Project 4 of Russian FTP Antarctica. The A.E.s stay at ILTS is supported by Japanese Society for Promotion of Science.

Keywords: paleo climate, ice cores, vostok station

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS006 **Oral Presentation** **891**

Holocene Antarctic climate variability from ice and marine sediment cores: insights to ocean-atmosphere interaction

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In this study we are attempting to quantify mainly temperature and sea ice variability, through integration of the available Antarctic ice core and marine sediment core data from the southeast Atlantic sector of the Southern Ocean. The ice core data that we have used are the d18O data from the EPICA DML ice core. In the analyses we have included sea surface temperature (SST) and sea ice reconstructions from two marine sediment cores. TN057-13PC4 is a 14-meter long piston core from 53.2S, 5.1E. The site is located at northernmost extent of sea ice influence south of the Antarctic Polar Front (APF), and at the southernmost extent of variability of the atmospheric APF. The record is dated by 8 AMS 14C dates and is covering the past 18,000-yrs. Site TN057-17 at 50S, 6E is situated at a water depth of 3700 m, flooded by Circumpolar Deep Water, and close to the southernmost extent of North Atlantic Deep Water. It is an 8.2-m-long section of Holocene diatom ooze, sampled every 110 cm to achieve a 2050 yr resolution. The record is dated by 11 AMS 14C dates and covers 13,000-yrs. The analysis reveals glacial-Holocene (23.3-0 cal. kyr. BP) climate trends in all three records largely governed by insolation changes. SiZer analysis shows a good agreement in timing of cold and warm climate events for all three records in the early Holocene, to approximately 9 cal. kyr. BP. We hypothesize that during this period the long term changes in SSTs and air temperatures represented by d18O content appear to be related to oceanic circulation changes forced by Northern Hemisphere summer insolation. In the late Holocene, however, the climate deviated from this relationship, to show affinity to local insolation instead. This change may be related to the intensity and/or position of the AFP, which occurs near the marine core sites today and may have been able to separate them from northern latitude influence in the late Holocene. The corresponding early Holocene long-term temperature trends are not well pronounced in the southernmost TN057-13PC4 site. This core is located in the modern AFP zone that sustains the SSTs just above the freezing point in the summer. The winter sea ice duration of two months on average at the site suggests, in its turn, that position of the AFP in this area may have remained approximately stable during the last 7000 years.

Keywords: paleoclimatology, holocene

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS006 **Oral Presentation** **892**

Energy transfer processes affecting isotopic fractionation in the near-surface snow pack on the Antarctic Plateau

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Department of Atmospheric Sciences University of Washington IAMAS

Von P. Walden, Stephen G. Warren

A one-dimensional finite-volume model is used to examine heat transport and water vapor pressure in the near-surface snow pack at the South Pole. The model (0-6.5 m) is forced at the surface with 10-minute skin-surface temperatures derived from routine measurements of upwelling longwave data made at South Pole from 1994 to 2003. The models lower boundary condition is a climatological temperature gradient at 6.5 m depth reported by Dalrymple et al. (1966). From the temperature profile time series produced by the finite-volume model we derive subsurface heat fluxes, heating rates, and vapor pressures on 10-minute to interannual time scales. The monthly mean heat fluxes at the snow-air interface range from -5 to +5 W m-2 throughout the year. However, on daily and sub-daily time scales we find interface heat fluxes of up to 20 W m-2, which are a result of variations in cloud cover and other synoptic atmospheric forcings. The short-time-scale heating rates of the snow pack are also surprisingly large, up to +10 K day-1 in the top 10 cm. The daily variations in these quantities average out to monthly mean heating rates of less than 0.5 K day-1. The heat fluxes and heating rates decrease in magnitude with depth. The temperature gradients in the snow pack cause vapor pressure gradients. An 18O-isotope process model is used in conjunction with the calculated vapor pressures to investigate the effect of subsurface energy transfer on post-depositional 18O-isotope fractionation. Much of the fractionation occurs during the short summer when temperatures are warmest and insolation is greatest. During the winter, snow pack temperature fluctuations are larger but water vapor pressures, and post-depositional fractionation, are suppressed due to the low absolute temperatures in the near-surface snow pack.

Keywords: isotope fractionation, energy flux, finite volume

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **893 - 902**

Symposium
Stable Water Isotopes: from Basin to Global Scale

Convener : Dr. Kendal McGuffie
Co-Convener : Prof. John Gibson

Stable water isotopes are a novel means of tracing and evaluating simulations of hydrological processes. Recent measurement campaigns (e.g. IAEAs Global Network of Isotopes in Rivers (GNIR) and Moisture Isotopes in the Biosphere and Atmosphere (MIBA)) are being combined with new international model intercomparisons (e.g. the World Climate Research Program and the Integrated Land Ecosystem Atmosphere Processes Studies (iLEAPS) iPILPS). This session provides an opportunity to present new work on stable water isotope techniques and tools from the basin scale to the global scale, including techniques for field and laboratory measurement, parameterisation of vegetation and soil effects together with basin to global scale integration of processes

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JMS007 **Oral Presentation** **893**

Relationship between stable isotope of precipitation and atmospheric circulation case study: application in a pilot basin in Middle Anatolia

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JMS007 Soil and water resources Ankara Research Inst IAMAS

A.Unal Sorman

The stable Isotope values of precipitation are strongly influenced by water vapor source and trajectory. Therefore, t can be used as a tool for the evaluation of atmospheric circulation. This approach requires an understanding of how atmospheric circulation influence precipitation δ 18O. This study presents to understand the relationship between atmospheric circulation and δ 18 O of individual precipitation events for a small basin in Middle Anatolia.. Circulation back trajectories, and δ 18 O values for 30 precipitation samples taken from 7 individual events were also examined to determine circulation type for each event. Results indicated that precipitation δ 18 O was related with precipitation intensity. Precipitations originating from S beria and Mediterranian Africa air masses seen high frequently in study area yielded relatively depleted δ 18 O values.

Keywords: 3precipitation, atmospheric circulation, trajectory

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **894**

Air parcel trajectory analysis of stable water isotopes in water vapour in the Eastern Mediterranean Region

Mr. Stephan Pfahl
Institute for Atmospheric Physics University of Mainz

Prof. Joel R. Gat, Prof. Heini Wernli

As a contribution to a research project of the International Atomic Energy Agency, measurements of stable isotopes in water vapour have been performed about twice a week in Rehovot in the coastal plain of Israel since 1998. For the interpretation of these measurements it is important to know about the history of the water vapour, especially its source regions and evaporation conditions. A key feature in this context, that has not been properly understood so far, is the d-excess that is related to kinetic fractionation. With the help of backward trajectories, calculated with the Lagrangian analysis tool LAGRANTO and based on operational analysis data from the European Center for Medium-Range Weather Forecasts, it is the aim of our study to identify the key processes during moisture uptake and transport that are responsible for the isotopic composition of the measured vapour. The trajectories are started in Rehovot during the measurement periods and calculated ten days backward in time. For further analysis, only parts of the trajectories without clouds and rain from above are taken into account. In this way the focus is laid on the conditions during evaporation from the sea, and other processes that could possibly mask the effects of fractionation during evaporation are excluded. Based upon an analysis of Lagrangian changes of specific humidity along the trajectories a moisture source diagnostic is performed, and the percentage of moisture arriving at Rehovot that can be assigned with our method to humidity uptake in the marine boundary layer is determined. Finally, for all dates where this percentage is high, several parameters like wind velocity, SST and humidity relative to saturation at the sea surface are diagnosed for the evaporation points along the trajectories. Correlations of these quantities with the measured values of the d-excess are explored, yielding detailed insight into the physical processes that determine this important parameter. First results for the year 2001 indicate a high anticorrelation between d-excess and relative humidity with respect to sea surface temperature.

Keywords: stable water isotopes, lagrangian based analysis, moisture transport

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **895**

Processes governing isotopic composition of precipitation in the Central Mediterranean, new insights from single rain event samples.

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Serafino Bellissimo, Rocco Favara, Mariano Valenza

The isotopic composition of precipitation is the result of several fractionation processes occurring during phase changes in the water cycle. The first involved process is the formation of water vapour from the sea surface. When under-saturated air travels over the sea, fast evaporation produces water vapour that is not in isotopic equilibrium with sea water. This process is responsible for the high values of deuterium excess found in meteoric waters of the Mediterranean Area. Water vapour travels until super-saturation is reached and condensation occurs. After nucleation, droplets usually growth in isotopic equilibrium with vapour. During the rain event the interaction between the falling drops and the surrounding atmosphere may change the original isotopic mark. In order to evaluate how such processes operate in the Central Mediterranean, rain water samples have been collected after every single rain eventin the period October 2005-September 2006 in the north-western Sicily (Palermo). Atmospheric dynamics has been supplied by meteorological models and by EUMETSAT satellite images. Meteorological parameters, such as temperature and relative humidity, have been obtained by balloon sounding data at Birgi (16429 WMO station) and by surface observations at Boccadifalco (16410 WMO station). Samples relative to 48 rain event have been analyzed for their isotopic composition. Analytical results have been compared with the surrounding atmospheric conditions relative to each rain event. Eventhough storms usually form when different air masses interact, making difficult the relation betweenisotope ratiosand atmospheric circulation systems, some important results have been highlighted. Re-evaporation processes, occurring during the falling of rain drops, seem to change the origin isotopic ratios only in 10 per cent cases. During each season, isotope ratios show an unexpected variability strongly depending on the atmosphere circulation systems. Winter cold and dry air masses travelling over the Mediterranean Sea generate rain with high deuterium excess (up to 29 per mil) while, during the summer, usually characterized by higher isotope ratios, the intrusion of colder air mass may generate very negative values.

Keywords: isotopic composition, rain, air masses

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **896**

Spatial and temporal relations between isotope ratios of water vapour and ocean surface conditions in the Southern Ocean

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Water isotopes preserved in polar ice cores provide invaluable earths climatic history over hundreds thousand years. A combined parameter of stable isotopes of hydrogen and oxygen in the water, the deuterium excess, adds information on ocean surface conditions of precipitations source regions. There are several evidences for changes in deuterium excess over ice-age cycles can be interpreted as changes in the ocean surface temperature at their moisture source, but present-day observation of deuterium excess of moisture above the oceans remains very limited. Here, we use this multi isotope approach with cold trap sampling of atmospheric water vapour on a ship, to investigate spatial and temporal relationship between the isotope ratios of vapour and meteorological conditions near ocean surface in the mid and high-latitude Southern Oceans. Field observation was conducted in the south Indian and Antarctic oceans at 15 m altitude on the R&T/V Umitaka-maru from 30 December 2005 to 30 January 2006. The deuterium excess shows significant correlation with relative humidity above the ocean and weak correlation with sea surface temperature. The results suggest that the relative humidity above the ocean is the main determinant of deuterium excess values of moisture near the ocean surface. We will discuss possible causes for such relations by comparing with the results from simple and complex models. These results provide a basis for interpretation of the d-excess in polar ice cores and present-day water circulation.

Keywords: water vapour, deuterium excess, water isotope

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **897**

MIBA-US: Temporal and spatial variation of water isotopes in terrestrial ecosystems across the United States

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Kevin P. Tu, Vanessa Boukili, Paul D. Brooks, Stefania Mambelli, Todd E. Dawson, Miba-Us Site Participants

The oxygen and hydrogen isotope ratios of soil and plant waters are powerful tools to identify the range of variation in water sources in terrestrial ecosystems, to partition evapotranspiration fluxes into evaporation and transpiration, and to validate global climate models. To date, water isotope samples have only been collected at very few sites for any particular region or continent and often these collections are not made in coordination with important complementary observations such as eddy covariance measurements of latent and sensible heat fluxes as well as carbon dioxide exchange. We present data on the seasonal and interannual variation in the oxygen and hydrogen isotope ratio of water from leaf, soil and stem samples across the 13 sites comprising the MIBA (Moisture Isotopes in the Biosphere and Atmosphere) network within the continental United States. The sites cover many of the major climatic and vegetation zones in the USA. These same sites are well characterized from a micrometeorological perspective and exhibit substantial variations in their water, energy and carbon fluxes.

Keywords: water isotopes, miba, terrestrial ecosystems

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **898**

Predicting the isotopic ratio of western European precipitation using an isotope trajectory model

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Katherine Eames, Peter Rowe

Spatial and seasonal variations of isotopic ratios in precipitation across Western Europe are well documented. Locations of moisture uptake, transport pathways, condensation temperatures, and surface temperatures at source region and precipitation location all influence the water isotope cycle. Isotope cycle modelling has been included in Global Circulation Models (GCMs) in order to model all of the controlling factors. However, the relative importance of each of these processes remains unclear due to the difficulties in decoupling these processes in GCMs. A combination of a Lagrangian Particle Dispersion Model and an extended Rayleigh distillation theory model allows the effects of different atmospheric processes on isotopic fractionation to be investigated. This method has previously been used to model precipitation in Antarctica and Greenland with excellent results. However, there are added complications involved when modelling rainfall rather than snowfall, such as isotopic re-equilibration between falling raindrops and the surrounding water vapour. Lower latitude locations also experience more evaporation and re-evaporation along the path of a moist air parcel, increasing opportunities for fractionation. These models have been used to predict the hydrogen and oxygen isotope ratios of rainfall in the U.K and Ireland. The model results have been compared with measured isotopic data from daily rainfall samples in order to test how the modelled processes interact. A case study is presented which incorporates observed data collected throughout November 2005 at stations in Norwich, Birmingham and Dublin, together with the corresponding temporal model predictions at these localities.

Keywords: isotope, precipitation, model

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **899**

Modeling stable water isotope composition over northwestern Canada

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The stable water isotope (SWI) composition of ice cores is conventionally assumed to provide a method of temperature reconstruction because of the temperature dependence of isotope fractionation when water forms in clouds. The isotope fractionation is also influenced, however, by the conditions under which the moisture originally evaporated and its transport between source and deposition regions. This complicates the use of ice cores as indicators of local climate, but also makes them useful as proxies of broader circulation patterns. The goal of our work is to better understand what controls the SWI composition of precipitation in the southwestern Yukon, and in particular, to better-interpret the SWI signal from the Mount Logan ice core. To this end, we are conducting experiments with the GISS ModelE general circulation model, which is equipped with SWI diagnostics. Preliminary results show that the model performs well in capturing regional and seasonal SWI variation at selected sites in . In the Yukon, SWI variability is controlled by both the local temperature as well as large-scale circulation anomalies such as the Pacific North America teleconnection pattern and ENSO. The strength of these relationships is highly dependent on seasonality, which provides a possible explanation for the lack of circulation signals detected thus far in the Mt. Logan ice core.

Keywords: yukon, climate model, ice core

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Oral Presentation** **900**

The isotopic signature of deep convective detrainment in a GCM

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Adam Sobel, Gavin Schmidt

Remote sensing of stable water isotope concentrations in the atmosphere provides a potentially valuable new tool for evaluation of the simulated hydrological cycle in global climate models. One area of particular concern in climate simulations is the representation of deep convective detrainment, as errors in this parameterization can impact estimates of both cloud and water vapor feedbacks to a warming scenario. We use results from the Goddard Institute for Space Studies ModelE to characterize the evolution of stable water isotope concentrations in air detrained from deep convection into the upper troposphere. Microphysical model parameters are varied within realistic bounds to create a range of detrainment schemes. The isotopic signature in the upper troposphere of each is examined. A preliminary evaluation of these predictions is performed using stable water isotope observations from the Canadian Space Agencys SCISAT-1.

Keywords: water, isotopes, gcm

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Poster presentation** **901**

Sensitivity of stable water isotopes to parameter changes in a land surface model

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Ann Henderson-Sellers

Stable water isotopes (HDO and H2O18) have received attention recently, in view of the potential for analysis of isotope pathways to provide information about basin scale hydrology not currently available from traditional hydrological observations. Stable water isotopes also have a role in the physiology of plants and can be useful in tracing the assimilation of carbon by plants. In order to provide a quantitative evaluation of the performance of stable water isotope models at the land surface, the iPILPS project (Isotopes in the Project for Intercomparison of Landsurface Parameterisation Schemes) has been comparing simulations of isotopic fluxes in land surface parameterisation schemes. iPILPS aims to provide a rigorous framework within which simulations of isotopic fluxes at the land surface can be intercompared, evaluated, validated and/or improved. Isotopes show complex responses to the hydrological parameterisations of different land surface schemes and some differences may be exaggerated by differences is canopy characteristics. Results from phase 1 of iPILPS presented a range of questions, which have been addressed by modelling groups. This paper presents results from tests on the sensitivity of the isotope climate of one land surface model (ISOLSM) to changes in model parameters.

Keywords: climate model, land, vegetation

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS007 **Poster presentation** **902**

iPILPS: Comparing simulations of stable water isotopes at the land surface

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Ipilps Participants

Parameterising the movement of stable water isotopes in models of the land surface developed for global climate models offers a means of evaluating simulations of transpiration, soil evaporation and canopy evaporation. Accurate determination of the partitioning of energy and moisture is important to land surface representation in global models, particularly in relation to accurate modelling of the rate of carbon uptake by the biosphere. Land surface models used in global climate studies typically treat the biosphere as a set of discrete reservoirs interconnected by flux pathways. Studies of large numbers of land surface schemes have shown that different model architectures produce characteristically different simulations of moisture and energy partitioning. In this paper we review the capabilities of land surface schemes currently incorporating isotopes; explore possible strategies for inclusion of isotopes at scales appropriate to global climate models and examine ways that stable water isotope tracking can be used to enhance the performance of land surface schemes.

Keywords: climate model, intercomparison, land surface

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **903 - 916**

Symposium
Clouds and Radiation and Air-Sea-Ice Interactions

Convener : Dr. Tom Lachlan-Cope

The transfer of energy from the ocean to the atmosphere at high latitude is controlled by many factors including clouds and flux transfer in the boundary layer over sea ice. This energy transfer plays a major role in driving the global ocean circulation and hence in controlling global climate. Contributions on new insights are welcome

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **903**

Air-Ice Interaction Observations in the Arctic seas

Dr. Irina Repina
air-sea interaction A.M. Obukhov institute of Atmospheric Physics RAS IAMAS

There are many methods reliable enough to determine the components of the energy balance for an old ice cover. However, over the areas of young thin ice and especially over open water areas in polynyas and leads, the conditions of heat exchange change: all the components of heat balance increase rapidly, and the turbulent heat flux changes its sign. Till now there are no reliable parameterizations of these processes. The present work is focused on studying the effects of structural and thermal non-uniformity at the ice covered surface on heat ad momentum exchange between atmosphere and underlaying surface. Transformation of air flow caused by change of the underlaying surface type (ice open water, fast ice - thin one year ice) is also envisaged. During different polar experiments our team carried out the following tasks: - Research of energy exchange of an atmosphere and surface (open water, ice) by measurements of turbulent heat and momentum fluxes in subsurface layer of atmosphere. - The determination of coefficient for parametric methods of calculating turbulent fluxes. The data are used for determinations of heat and momentum fluxes, as well as roughness parameter of a surface. The measurements were carried out both during a course of a vessel, and at ice stations; measurement of spatial distribution of surface temperature in IR-range. Vertical turbulent fluxes in the polar regions essentially depend on the type of the underlying surface. Eddy-covariance method allows direct measurements of turbulent fluxes under various background conditions. This method proved to be reliable both in the Arctic and in the Antarctic. Exchange coefficients, calculated using direct measurements do not correlate with any single meteorological parameter, but rather depend on an ensemble of factors, which are usually difficult to estimate. Profile method of turbulent flux calculation provides results, which coincide with direct measurements only under the conditions when Monin-Obukhov theory is valid. Calculation of turbulent fluxes in the confined area with irregular underlying surface requires careful selection of method of calculation and type of parameterization of coefficients. Measurements of the atmospheric turbulence characteristics directly from ice, in the absence of the ship effect and vibration, allow to receive more accurate results, especially at small values of turbulent fluxes. When breaks are formed in ice, strong outgoing fluxes are formed due to a large difference in temperature. The heat fluxes over polynyas are one or two orders of magnitude greater than those over the pack ice. However, up to 50% of the whole turbulent exchange between the ocean and atmosphere occurs over this small area. The value of the drag coefficient CD experimentally obtained for polynyas was 1.49 x 10 -3, which is smaller than that for ice covered with hummocks, but greater than that for the open ocean. The effect of the bottom relief in the shallow water on the processes in the near-surface layer of the atmosphere is discussed. In particular, the energy exchange processes were found to be intensified in the region of the shelf edge. The air-sea-ice investigations in polar regions are considered in the IPY tasks frame.

Keywords: turbulence, polynya, parameterization

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JMS008 **Oral Presentation** **904**

High quality measurements and parameterization of short wave radiation fluxes at sea: MORE results.

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Sergey K. Gulev, Marina Aleksandrova

The existing parameterizations of short wave radiation fluxes at ocean surface were primarily validated under mid latitudinal conditions and they suffer form a number of uncertainties associated with both clear sky radiation and cloud reduction factor. During 2004-2006 under the MORE programme we undertook high resolution research quality observations of short wave radiation fluxes and associated meteorological characteristics at several meridional sections in the Atlantic Ocean from approximately 60N to 60S. Short wave and long wave radiation fluxes were measured by the Kipp&Zonen net radiometer CNR-1 with temporal resolution of 10 seconds. Altogether the data base of in-situ measurements consisted of about 140 daily time series of short wave radiation. These data were used for the further development of a new parameterization of radiative air-sea exchange. First we analysed clear sky radiation and found that the logarithmic dependence of short wave radiation on the solar altitude is more accurate than the traditionally used linear approximation. For the cloud correction factor we suggested for the first time to analyse the dependency of transmission factor on the cloud types rather than on the total cloud cover. This approach allowed for considerable improvement of the radiation parameterization, especially under moderate cloudy conditions and complete overcast. Newly designed parameterization allows for the improvement of the accuracy of short wave radiation flux from 5 to 15% with the largest improvement for cloudy conditions. Some pilot applications of the new parameterization to the massive short-wave radiation computations are discussed.

Keywords: short wave radiation fluxes, in situ measurements, radiation parameterization

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JMS008 **Oral Presentation** **905**

Reconstruction of surface turbulent fluxes in the North Atlantic: 1880-2004

Prof. Sergey Gulev
JMS008 IAMAS IAMAS

Using 125 years (1880-2004) of Voluntary Observing Ship (VOS) observations from ICOADS we reconstruct surface ocean-atmosphere heat fluxes over the North Atlantic with monthly resolution in time and variable (2-degree to 5-degree) resolution in space. Methodology of reconstruction is based on the homogenization of sampling density, application of the double-exponential distributions of turbulent fluxes for minimizing sampling errors and the use of specially adopted for incomplete data coverage bulk-algorithms. In particular, a multi-regressive approach is used to reconstruct atmospheric humidity, playing important role in estimation surface fresh water fluxes. The methodology was first validated using the time series from VOS and reanalyses for the well sampled last several decades. Produced air-sea flux fields show reasonable minimization of sampling errors and allow for the analysis of regional heat balances and estimation of long-term changes in surface fluxes. Further analysis included computation of monthly anomalies of surface fluxes as well as estimation of the subpolar gyre heat and freshwater budgets. These were computed using two-demensional distributions of surface fluxes in the coordinates of sea-air temperature difference and wind speed. Reconstructed fluxes reveal long-term trends, implying, for example, about 4 W/m2 per decade growing sensible heat fluxes in the Labrador Sea and about 2 W/m2 per decade secular increase in the Central subpolar gyre. Non-secular signals are represented by the decadal-scale and multidecadal (about 40-50 years variability). Decadal scale signal has a clear association with the NAO-like atmospheric circulation variability during 1880-1915 and after 1955, but has a little association with NAO between 1915 and 1955.

Keywords: air sea fluxes, atlantic, computations

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **906**

A Diagnostic Study of Antarctic Fog

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Like all other continents on the Earth, Antarctica experiences fog events that in turn impact logistic operations in the support of research activities on and around the continent. Case in point, the United States Antarctic Program (USAP) hosts a significant air operations with over 700 flights planned each year, many of which fly through the main hub at McMurdo Station, Ross Island, Antarctica. Fog is the number one weather phenomenon impacting USAP aviation activities. This presentation will offer a brief history of Antarctic fog, and the overlapping fields of study that lead to the diagnostic study in the Ross Island region of the Antarctic presented here. Continental and marine regimes influence this region. A simple fog particle collection experiment will be discussed and will reveal findings that fog particle sizes are on order of 7.5 to 10 microns in diameter. The general climatology of fog events from a thirty plus year record at McMurdo Station, Antarctica will be reviewed with some key relationships to the nearby skiways and runways. Next a classification of fog types is analyzed along with an introduction to modern satellite methods used to distinguish fog, and applied to the Antarctic. Some unexpected fog types may occur in the Antarctic (such as mixing fog), while expected types may not appear as often. Finally a case study is used to demonstrate the environment in which fogs occur for the Ross Island region of the Antarctic an environment very close to that of the climatological mean. Future directions for the study of Antarctic fog are outlined from microphysical through mesoscale and synoptic scales.

Keywords: fog, antarctica, observation

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **907**

The role of radiation and boundary layer parameterization schemes in simulating the atmospheric flow over the ocean and land surfaces

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Julia Palamarchuk

There are key advantages in using numerical models to study air-sea interactions and transfer of energy in the planetary boundary layer (PBL). On this way, individual weather systems can be homogeneously evaluated over a domain of interests. Secondly, physical processes of interacting can be studied in detail in terms of heat, momentum and moisture fluxes. However, the present models are still not perfect. Their formulations contain different sorts of shortness, and model results are not free from uncertainties. The goal of this work is to search the optimal set of parameterization schemes for radiation and processes in the PBL available in the MM5v3.7 model. This can highlight important aspects of the simulation of the atmospheric flow all the way from the short range to the medium range and beyond. Further, the comparison of the model results against a re-analysis allows us to estimate systematic model errors for the main diagnostic variables as well as their derivatives, such as the fluxes through the oceanic surface. The topics are addressed to (i) evaluate the spatial structure and magnitudes of fluxes over the ocean and the consequent flux transfer in the atmospheric boundary layer; (ii) asses systematic model error for major atmospheric fields; (iii) determine geographical regions where model errors are largest and how they are related to the most active interaction processes; (iv) define particular atmospheric patterns contributing to the fast and significant model error growth. Results are presented for the Atlantic-European domain during winter 2002. Various combinations of parameterization schemes for the cumulus, PBL, moisture and radiation are used to identify which one provides a lesser difference between the model state and analysis. The comparison of the model fields is carried out versus ERA-40 reanalysis of the ECMWF. Results show that the rate, at which the model error grows as well as its magnitude, varies depending on the forecast range, atmospheric variable and level. The typical spatial scale and structure of systematic model error also depends on the particular atmospheric variable. The distribution of the error over the domain can be separated in two parts: the steady and transient. The first part is associated with the type of the surface. Over the ocean the model overestimate the wind and temperature, while over the continent it underestimates these atmospheric variables. The transient model error mainly moves along with areas of high gradients in the atmospheric flow. Acknowledgement: This study has been supported by NATO Science for Peace grant #981044. The MM5 modelling system used in this study has been provided by UCAR. ERA-40 re-analysis data have been obtained from the ECMWF data center.

Keywords: energy transfer, air sea interactions, systematic model error

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **908**

Flux measurements over a polynya in the Weddell Sea.

Dr. Tom Lachlan-Cope
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Alexandra Weiss, Emma Feidler

It is thought that the polynyas in the Weddell sea are the source of much of the sea ice found in the Weddell Sea. The cooling of the surface water and the rejection of brine when sea ice forms creates dense water which sinks and flows north into the Atlantic forming bottom water. Very few measurements of energy exchange between atmosphere and sea have been have been over the Weddell Sea polynyas. To help understand this complex area we have used the British Antarctic Survey's newly instrumented Twin Otter aircraft to measure the turbulent and radiation fluxes over the polynya during the austral sumer. The airborne eddy correlation measurements during made during a cold outbreak show intense turbulent fluxes confirming the results obtained by using bulk parameterisations. These data were used to validate a simple model of the polynya and results from this model are presented here.

Keywords: sea ice, turbulent heat flux

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **909**

A variational cloud retrieval scheme combining radar, lidar and radiometer observations

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Robin J. Hogan

Recently CloudSat and Calipso have joined Aqua and other satellites as part of A-Train constellation, which constitutes an exceptional opportunity to improve our understanding of clouds role in the earth radiation budget. However the actual algorithms (radar+lidar or radar+radiometer) have not the capability to exploit the full synergy, hence the necessity to develop new methodologies to use the combination of radar, lidar and radiometer. In this talk a unified retrieval scheme is described that uses a variational approach to combine cloud radar, backscatter lidar and both infrared radiometer to retrieve the properties of liquid and ice clouds. The rigorous treatment of observational errors and careful use of additional constraints enables the retrieval to blend smoothly in the vertical between regions where different instruments are sensitive. For example, a deep ice cloud viewed from above by CloudSat and Calipso would typically consist of a top region detected only by the lidar, a central region where both radar and lidar can be used to infer particle size, and a base region detected only by the radar. The MODIS infrared channels contain particle size information but are weighted towards the cloud top region. The unified scheme retrieves an optimum profile of cloud variables that best fits the observations. The efficiency of the method is facility by a new ultra fast lidar multiple scattering forward model. The scheme has been tested on ground-based observations from the Cloudnet project, and is now applied to global observations from the A-Train of satellites. Once clouds parameters (extinction, effective radius, ice water content) obtained, it will be relatively straightforward to use them to built climatology and/or evaluate the skill of GCM models.

Keywords: clouds, radar lidar radiometers, cloudsat calipso aqua

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS008 **Oral Presentation** **910**

Antarctic clouds from above and below

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In the framework of the British Antarctic Surveys current project FOCAS (Forcings from the Ocean, Clouds, Atmosphere and Sea-Ice) one aim is to improve the information available on clouds over Antarctica. Ground-based data sets used for this mean come mainly from bases Halley (Z), Rothera (R) and Faraday/Vernadsky (F) and consist of synoptic observations (available since 1960 at F and Z, since 1977 at R), radiosondes (available since 1957 at Z, from 1954 to 1982 at F, and since 2002 at R) and ceilometer data (available since 2003 at R and Z). Synoptic observations provide parameters such as cloud amount, cloud base height, and cloud type. The ceilometers have a rang up to 25000ft and directly deliver cloud base heights of up to three cloud layers but the full backscatter signal is used in this study. Humidity profiles gained from radiosondes will be a third means to retrieve information about the existence of clouds, their base height, vertical extension and cloud top temperature. These spatially very limited data sets are complemented by satellite data from the NOAA series of polar orbiting meteorological satellites received at Rothera since early 1993. This AVHRR data (Advanced Very High Resolution Radiometer) delivers approximately eight passes per day that cover the at least one of the bases with a spatial resolution of about 1km. The ground-based observations on their own are used in a first step to set up a climatology of cloud characteristics for each of the stations and are analysed for trends. In a second step data from the stations is compared to cloud parameters retrieved from the satellite data. For this part of the investigation the radiometer measurements at different wavelengths themselves are used and they are also fed into CASPR, a model for Cloud And Surface Parameter Retrieval, especially developed by NOAA for polar AVHRR data. With the ground-based data as tie points the satellite data will be used to retrieve cloud information for a huge part of Antarctica at a high spatial resolution. Applying the coherences gained in the previous step to the entire archive of AVHRR data will create the beginning of high-resolution cloud climatology for the Antarctic. This presentation will show results from the analysis of the ground-based observations as well as first results from the combination of satellite and ground based data.

Keywords: avhrr, ground based observations, antarctica

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JMS008 **Oral Presentation** **911**

Aerosol Elemental Mass Size Distributions at Baia Terra Nova (Antarctica): Properties and Interactions of Three Major Components of Natural Aerosol

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Daniele Ceccato, Vito Trov, Francesco Chiminello

We consider in what follows three major components of Antarctic natural coastal aerosol at the clean site Campo Icaro (Lat. 744243S, Long. 1640658E, near the Italian Base M. Zucchelli on the Ross Sea), with little influences from other continents. The components are sea-salt (ss) aerosol; crustal (cr) aerosol and the submicrometric accumulation mode of Sulphur compounds. They play important roles in the climatic processes, in particular in connection with: atmospheric chemistry (gas-particle interactions); climatology (interactions with solar radiation; DMS negative feedback); sea-air transport of crustal materials (by ss aerosol). Moreover, their variability must be connected with intra and inter-seasonal variability of meteorology and environment. A multiannual experiment on coastal aerosol is being performed during the summer season. Size-segregated aerosol samples collected (48 hrs duration) with an SDI 12-stage impactor are submitted to PIXE analysis and the size distribution, EMSD, of the mass concentration (ng m-3) of up to 9 elements, (with Z 11) is obtained in the size range 12.0.047µm. We present the partial results (11 samples) of the 2002/2003 campaign, which display a substantial reduction of the background level with respect to the published 1999/2000 results, and allow a successful representation of the EMSDs of 7 crucial elements (Na, Si, S, Cl, K, Ca, Fe) with one or two lognormal functions, in the full dimensional range, in almost all cases. The scientific results concern properties and variability of a crustal component, cr, (identified by the strong correlation between Si and Fe and by the stable value of their ratio); the considerable stability of the submicrometric S (accumulation) mode; the strong variability of the EMSDs of Na and Cl, the similarity of their shapes, displaying however a size-dependent Cl-depletion, ΔCl, of the sea-salt component, ss; a strongly variable size-dependence of the difference, nss (non-sea-salt S), between S (total) and ssS (sea-salt S) in the supermicrometric region; the contributions of K and Ca to ss and cr. Significant scientific problems include: (a) the strength and variability of fluxes to and from ss aerosol of gaseous S and Cl compounds, as measured respectively by supermicrometric nssS and by submicrometric and supermicrometric ΔCl; (b) specific properties of gas-particle interactions (on-surface vs in-volume interactions), as measured by using the shapes of nssS and ΔCl; (c) the interpretation of optical data concerning the interaction between solar radiation and aerosol; (d) the connection between variability of aerosol properties, in particular the integrated quantities Natot Stot(sub), nssStot, etc, and variability of meteorological and environmental parameters. Internal mixing of cr and ss components will be investigated by means of Principal Component Analysis, with the previously [1] deed procedure or/and single aerosol particle microPIXE analysis. [1] F. Chiminello, P. Mittner, A. Trevisiol and D. Ceccato. Proc. 16th Int. Conf. on Nucleation and Atmospheric Aerosols (ICNAA), Kyoto, 2004, pp.649-652

Keywords: antarctic aerosol, elemental composition, pixe

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JMS008 **Oral Presentation** **912**

Observational and Model-Simulated Analysis of Severe Wind Storm event in the Ross Ice Shelf

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Azizan Abu Samah

On May 15 -16, 2004, Scott Base in Antarctica was struck by the most severe windstorm in the last 12 years. Maximum gust of 180 kmph was recorded at the base. The neighbouring McMurdo station, the largest base of the United States Antarctic Program (USAP), also recorded high wind speed. This high wind caused damages to the outlying structures as well as vehicles at the Scott Base. Fortunately, no one was injured due to the arrival of the severe windstorm in the early morning hours. This paper aims to carry out detailed observational analysis of this May storm using available observational data as well as the results of numerical simulation from the Polar MM5 (PMM5) model. In this study we have also tried to investigate the nature of the high wind event that occurred 14 May 2004. In the simulation work, four polar stereographic domains, viz. 60km, 30 km, 10 km and 3 km resolutions are used. In addition, the model is initialised twice daily, i.e. at 0000 and 1200 UTC. A comparison of similar simulation results from both the Antarctic Mesoscale Prediction System or AMPS (Obtained from Daniel F. Steinhoff of Byrd Polar Research Center) and PMM5 simulation was undertaken to highlight the performance and capability of the two models to represent the severe windstorm features over the Ross region. The comparison indicates that ingestion of various observational data into AMPS shows better skill of the model in simulating the certain features of the severe windstorm.

Keywords: gust, storm, katabatic

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JMS008 **Oral Presentation** **913**

Global albedo anomalies measured by MISR from 2000-2006: recent darkening at high northern latitudes

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From 2000 to 2005, the deseasonalized anomalies in time series of the globally averaged top-of-atmosphere spectral albedos measured by MISR appeared to show little of sustained interest. However, a significant decrease was detected during mid 2006. This anomaly disappeared by the end of 2006 and does not appear to be an instrumental or sampling aberration. The anomaly is restricted to latitudes north of 40 during late Spring and early Summer, and is large enough to affect the global annual average. The implications of this measurement for sustained ice/snow-albedo feedback will be discussed.

Keywords: top of atmosphere albedo, ice albedo feedback, albedo anomalies

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JMS008 **Oral Presentation** **914**

Ice forming processes in Antarctic mixed-phase clouds

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The presented study is focused mostly on the investigation of ice forming processes in precipitating clouds over the Antarctic Peninsula for the different seasons with aid of numerical models. So-called the Combined Model of the Cloudy Troposphere (CMCT) which is a combination of 3D mesoscale diagnostic and 1D microphysical prognostic numerical models developed in UHMI was applied. 3D mesoscale diagnostic model on the domain 1500x1000x10 km with resolutions of 25 km horizontally and 100 m vertically was constructed based on upper-air sounding data of Bellingshausen radiosonde station. 1D model included spectral microphysics with 100 bins for each of three types of cloud particles (droplets, raindrops, ice crystals approximated by spheres or plates) formed on activated ice (IN) and cloud condensation nuclei (CCN) and interacted with one another by collision, condensation, evaporation, sublimation, freezing, etc. This 1D model was constructed based on the outputs of the above 3D model as the most close to the observed thermodynamical fields. The model allowed obtaining both spectra of cloud particles and the following integral microphysical characteristics developing in time over a fixed point on the 3D domain: rain and snow (or sleet) precipitation intensities and sums, ice (IC) and liquid water contents (LWC) and particles concentrations.The first recent numerical simulations of Antarctic cloudiness microstructure with the above models revealed that the number of ice crystals present in the cloud was much larger than would be expected at the same temperature at mid-latitudes. At the same time, very few observations made high on top of the Antarctic Peninsula from the ground suggested the same: ice particle concentrations were typically one or two orders of magnitude greater than those in mid-latitude clouds at similar temperatures. This fact forces to pay an extremely high attention to the ice forming processes in Antarctic mixed-phase clouds, since, their correct parameterization in GCM or other atmospheric models would eliminate errors, e.g., in a highly sensitive radiative transfer, etc.New parameterizations from the recent Khvorostyanov and Curry publications for terminal velocities of droplets and crystals and for rates of homogeneous and heterogeneous nucleation were implemented in the model. Preliminary results and the comparison with the previous parameterizations will be presented. We hope to get a possible verification of the above parameterizations of the ice forming processes in Antarctic mixed-phase clouds during IPY.

Keywords: antarctica, cloud microphysics, ice formation

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JMS008 **Oral Presentation** **915**

Visibility parameterizations for precipitation rate and relative humidity during the Fram Fog field project

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The purpose of this work is to develop visibility parameterizations (Vis) as a function of precipitation rates (PR) in either rain or snow, and visibility as a function of relative humidity, using surface observations that were collected during the Fog Remote Sensing and Modeling (FRAM) field project. This project was conducted nearby Toronto, Ontario, during the winter of 2006-07 and in Lunenburg, Nova Scotia, during summer of 2006. The main observations used in the analysis were precipitation rates for rain and snow and visibility from the VAISALA FD12P instrument, and relative humidity and temperature from the Campbell Scientific HMP45. In the past, visibility parameterizations related to precipitation type have been studied in detail by many other researchers. Their results showed large variability in Vis (up to 1 order of magnitude) for a fixed precipitation rate. In fact, Vis at the surface stations (e.g. airports) is usually measured by human observers that cause a large uncertainty in the derived relationships. The results suggested that 1) significant differences exist among the various parameterizations of Vis and they cannot be applicable for forecasting models, and 2) using statistical relationships e.g. fits for percentiles, visibility analysis from the models can easily be compared to observations. Comparisons of previous parameterizations to the new visibility relationships suggested that simulated visibility values could be improved significantly.

Keywords: visibility, snow, rain

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JMS008 **Poster presentation** **916**

Investigation of the atmospheric boundary layer over Antarctic sea ice by eddy correlation measurements

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Tom Lachlan-Cope, Russ Ladkin, John King

In the Antarctic, sea ice has a large impact on the energy and radiation budget of the atmospheric boundary layer, because solar radiation is reflecting from the ice surface and the ocean surface is insulated by the ice from the atmosphere. However, up to now little is known about the complex feedback mechanism between air, sea and ice and their parameterization in models. For the investigation of the turbulent atmospheric boundary layer over sea ice in the area of the Antarctic Peninsula an airborne field campaign was conducted during the austral summer. To study the most important links between air, sea and ice - the turbulent and radiative fluxes - a Twin Otter aircraft was newly equipped with an eddy correlation system and standard meteorological instruments. In this contribution we give a brief overview of the aircraft instrumentation, which allows the measurement of the turbulent fluxes of momentum and heat, the air and surface temperature, humidity and radiation. We discuss the temporal and spatial variability of the turbulent fluxes for various sea ice, measured in the Weddell and Bellingshausen Seas. The analysis of the data clearly shows how varying sea ice leads to a drastic change in the ocean surface albedo and temperature. However, spatial variability of the atmospheric turbulent fluxes depends not only on the sea ice condition, such as sea ice concentration, but also on the stage of the development of the boundary layer. This is discussed by analyzing the sensible heat flux data with the joint frequency distribution technique.

Keywords: air sea ice fluxes, antarctic, turbulent boundary layer

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JMS009 **917 - 975**

Symposium
Hydrological Cycle, Precipitation and Precipitation Systems

Convener : Prof. Ronald Stewart

The hydrological cycle is a fundamental aspect of the Earth's climate system and it must be well understood if we are to better predict our varying and changing climate. This Symposium focuses on assessing our present capabilities to determine, understand and predict the hydrological cycle on global to regional scales including its variations and extremes as well as on examining how it may change in the future. Because precipitation is such an important aspect of the hydrological cycle and also has major direct impacts, special attention will be paid to it. This will include an examination of the precipitation cloud systems that produce this precipitation and play a major role on the hydrological cycle. Studies based on observations, theory, and modeling are all welcome

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JMS009 **Oral Presentation** **917**

Regional rainfall projections refining model-based estimates using observed trends.

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A problem with climate change projections at the regional scale is the relatively large uncertainty that tends to accompany them, partly as a consequence of constructing an ensemble of results based on different climate models with different responses. Efforts to reduce this uncertainty often rely on effectively filtering out, or giving less weight to some model results based on various criteria related to their performance. It is argued that, because considerable time has elapsed from the baseline date for most climate change projections (1961-1990), any observed trends over recent time are likely to contain useful information which can also be used to refine the model based estimates. Here a method is described which attempts to refine estimates for regional rainfall changes expected over the next few decades using the fact that, for some Australian regions, the observational record indicates significant trends already exist and, if global warming continues, these may reveal the true direction in which the climate system is evolving. The regions include south-west Western Australia (SWWA), which has been getting drier during the winter months, north-west Australia (NWA), which has been getting wetter during the summer months, and two other regions referred to as south-east Queensland (SEQ) and Victoria VIC), where it has been getting drier during summer. In the case of SWWA, the observed trends tend to agree with most model estimates whereas for NWA, they differ significantly. In the case of SEQ and VIC, they support approximately half, since the model estimates are uncertain with regard to the sign of the changes. A Bayesian approach for combining both sources of information with the aim of refining the model projections is presented. This leads to refined estimates for both median values and the 5% and 95% confidence intervals, and a reduction in the uncertainty associated with the original estimates.

Keywords: rainfall, trends, projections

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JMS009 **Oral Presentation** **918**

Flood in Bangladesh : How to face the Challenge

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Flood in Bangladesh is almost a regular phenomenon. It comes sometimes with wider scale and longer duration. Three international rivers the Ganges, the Brahmaputra and the Meghna pass through Bangladesh. This river system drains an area of 1.72 million sq. km in China, India, Nepal, Bhutan and Bangladesh of which only 7 percent lies in Bangladesh. This river system shapes the daily life of the people and plays a significant role in the Economic sector, Cultural and Social development in this region. Flood brings the threat to the lives during the period of monsoon and causes catastrophe in normal life pattern of the human society. Some degree of flooding is beneficial for the agriculture and fisheries. Major floods play havoc with crops, property and peoples lives. The normal sequence of floods starts with flash floods in the northern districts of Bangladesh and plains of Assam in the month of April-May just before the onset of monsoon over Bangladesh. The flood effect over the region gets its peak value with the onset of monsoon in Jun-Jul period and lasts till the late September. Bangladesh with a population of 120 million experienced worst flood in 1987, 1988 and 1998. The current frequency of severe floods is posing significant threat to the Economy of the country. Floods in this region have become a regular occurrence and needs to be tackled on the basis of international cooperation. With the increasing population and lesser availability of the cultivable land, Bangladesh requires flood control to allow high yielding crops to grow in the monsoon season. The farmer of the region does not want to take the risk with costly high yielding variety of the crop due to the threat of the periodic catastrophic flood. Recently, the frequency of this type of flood has increased. A more secure environment is required to foster the institutional and individual confidence necessary to encourage and sustain rural and urban economic growth. Responsible and reliable forecasting and warning system along with the manifestation on flood mitigation can help us in this regard. An in-depth study has been done to find the suitable methodical forecasting of synoptic systems which brings flash flood situation in the Northern districts and ultimately over rest part of Bangladesh.

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JMS009 **Oral Presentation** **919**

GEWEX Water and Energy Budget Studies

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During the past several years, the Global Energy and Water-Cycle Experiment (GEWEX) Continental Scale Experiments (CSEs) began an attempt to develop the

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JMS009 **Oral Presentation** **920**

Modélisation de la relation pluie - débit par les reseaux de neurones artificiels (RNA) : Cas du bassin versant de l' Oued Haddad (Nord Ouest de l'Algerie)

Dr. Achite Mohamed
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Cet article prsente une mthodologie de ltude de la relation pluie-dbit par les rseaux de neurones artificiels (RNA). Dans ce travail, lalgorithme de rtropropagation utilis est le perceptron multicouche (PMC). La fonction dactivation est de type sigmode. Pour la prdiction du dbit, nous prsentons lentre du rseau de neurones les valeurs mensuelles des dbits et des pluies observes des instants prcdents. Lapplication du rseau des donnes pluviomtriques et dbimtriques du bassin versant de loued Haddad en zone semi aride, permet dobtenir une bonne simulation des dbits. Les coefficients de corrlation entre les valeurs observes et simules varient de 0,40 0,87 pour les phases dapprentissage, de test et de validation.

Keywords: simulation, rseaux de neurone, relation pluie dbit

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JMS009 **Oral Presentation** **921**

Characterization of Iberian autumn precipitation through observed, simulated and reanalysed data

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M. Luisa Martn, Marcos Sotillo, Francisco Valero, Ana Morata, Yolanda Luna

A 44-year (1958-2001) homogeneous Mediterranean high-resolution atmospheric database was generated through dynamical downscaling within the HIPOCAS Project framework. The present work is focused on the analysis of the 41-autumn (1961-2001) monthly HIPOCAS precipitation reliability over the Iberian Peninsula and the Balearic Islands, being also provided an evaluation of its improvement versus global reanalysis data sets. A statistical comparative analysis between observed, HIPOCAS and global reanalyses precipitation data sets were carried out highlighting the noticeable agreement existing between the observed and the HIPOCAS precipitation data sets in terms of not only time and spatial distribution, but also in terms of total amount of precipitation. The results also showed the important improvement introduced by the HIPOCAS hindcast in comparison to global reanalysis data, being highlighted the great potentiality of such regional hindcasted data set. A principal component analysis is carried out showing that the patterns derived from the HIPOCAS data largely capture the main characteristics of the observed field. Moreover, it is worth to note that the HIPOCAS patterns reproduce accurately the observed regional characteristics linked to the main orographic features of the study domain. High time correlations between the hindcasted and observed PC time series point out great similarity between the two datasets, corroborating the model performance ability.

Keywords: autumn iberian precipitation, statistical comparison, improvement hincasted data

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JMS009 **Oral Presentation** **922**

Tropical North African hydroclimate variability

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Tropical North African hydroclimate variability is investigated. It is found that hydroclimate is characterised by ENSO and decadal timescales. The mechanisms that control tropical North Africa hydroclimate over Nile, Chad, Senegal and Niger (at Niamey and Mali) are unravelled from NCEP/NCAR ocean-atmospheric reanalysis data using composite analysis. The temporal spectral energy and mode of variability for the Nile River stream flow (1900-1996) is investigated using continuous wavelet transform. It is found that large-scale east-west overturning of Atlantic and Pacific drive the hydroclimate swing of North Africa through the upper-level velocity potential dipole and convection polarity with South America. The ENSO mode determines the pole and the strength of this polarity through these zonal circulations: Pacific and Atlantic Walker Cells. The same circulations dictate the Sahelian climate, economy and agriculture

Keywords: tropicalhydroclimateswings, modulatingmechanisms, monsooncirculation

Characteristics of the Cloud Water Resources of Sichuan

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Using 30a ground observational data from representative meteorological stations in Sichuan, this study addresses the characteristics of the cloud water resources of Sichuan. The study is based on the monthly average temperature and monthly gauge-average total rainfall data of 1971-2000 collected from 8 meteorological stations. The eight stations are selected not only for their long and sound observations but also for their geographical locations. They are Chengdu station (104.02 E, 30.67 N) in West Sichuan Plain, Yibin station (104.60 E, 28.82 N) in South Sichuan Hills, Guangyuan station (105.85 E, 32.43 N) in North Sichuan, Suining station (105.58 E, 30.50 N) in Central Sichuan, Dazhou station (107.50 E, 31.20 N)) in Northeast Sichuan, Ganzi station (100.00 E, 31.62 N) in North Sichuan Plateau, Xichang station (102.27 E, 27.90 N) in Central Sichuan Plateau, and Yanbian station (101.53 E, 26.92 N) in South Sichuan Plateau. The evaporation is calculated with the experiential formula (Hiroichiro 1979) E=3100R/ {3100+1.8R*R*exp [-34.4T/ (235+T)]}, where E denotes evaporation, and R denotes monthly gauge-average total rainfall, as well as T denotes monthly average temperature. The cloud water resources are evaluated with the formula (Song et al. 1999) F=R-E, a=E/R, b=1-a, where F denotes cloud water resource, and a denotes evaporation coefficient, as well as b denotes cloud water coefficient. It is found that the annual total cloud water resource in West Sichuan Plain is 308.50 mm, 335.41 mm in South Sichuan Hills, 336.35 mm in North Sichuan, 240.78 mm in Central Sichuan, 431.26 mm in Northeast Sichuan, 317.29 mm in North Sichuan Plateau, 430.65 mm in Central Sichuan Plateau, 519.24 mm in South Sichuan Plateau. That is, the average annual total cloud water resource of Sichuan is 364.94 mm. It is obvious that the exploitable potentialities of the cloud water resources of Sichuan are considerable. Moreover, the majority of cloud water resource in Sichuan exists in summer (June, July, August), which gains 67.13 percent of the annual total cloud water resource; while only 0.44 percent of the annual total cloud water exists in winter. Meanwhile, 10.80 percent of the annual total cloud water is contributed in spring and 21.63 percent is contributed in autumn. Respectively, 70.23 percent of the annual total cloud water in the plateau area of Sichuan is contributed in summer; 0.08 percent of that is contributed in winter; 65.28 percent of the annual total cloud water in the rest area of Sichuan is contributed in summer; 0.65 percent of that is contributed in winter. It is clear that the seasonal difference of the cloud water resource in Sichuan is obvious. In addition, the annual average cloud water coefficient in Sichuan is 0.38. Respectively, the cloud water coefficient in Sichuan in summer is 0.46, and 0.03 in winter, 0.38 in spring, 0.34 in autumn. Thus, the exploitable potentialities of the cloud water resources of Sichuan vary with season, the biggest in summer, the least in winter.

Keywords: cloud, water, precipitation

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JMS009 **Oral Presentation** **924**

Modelling point rainfall occurrences using a Bartlett-Lewis stochastic rainfall model

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Fatemeh Zanir

The simulation of continuous rainfall time series is currently an important area of meteorological research. A developed random pulse model, known as Modified Bartlett-Lewis Model Using Poisson, Gamma and Weibull Distributions (MBLMPGWD) is applied to 24 hours maxima and hourly rainfall data, obtained from two Iranian sites. The model and parameter estimation is carried out using a three-stage process. In the first step parameters in relation to random entrance of storms and cells, which following up Poisson's process, calculated. These parameters then were used as primary data for calculation of the other parameters in Delta method, and finally in the third step Weibull's distribution parameters were calculated using Newton Rafson successive approximation. For testing and evaluating of simulated quantities produced by model, Heidke skill score and various statistic criteria such as simulated graphic drawing, scatter diagram, correlation coefficient and root mean squares errors were used. MBLMPGWD model in simulating 1 and 24 hours maximum rainfall is superior to the primary Bartlett-Lewis models. Simulated extreme rainfalls which have been produced by modified model are properly in agreement with observed data. The possible reason for improvement of model is using of Weibull distribution for monitoring rainfall cells and intensity of storms. These results indicate that Weibull distribution in comparison to exponential, Gamma and Pareto distributions has better flexibility for various tails.

Keywords: bartlett lewis model, extreme rainfall simulation

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JMS009 **Oral Presentation** **925**

Diurnal Variations of the Meiyu/Baiu Rain Belt Observed by the TRMM Precipitation Radar

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Hiroyuki Yamada

The Meiyu/Baiu Rain Belt develops over East Asia in springtime in association the Meiyu/Baiu front. It extends from the inland of China to Japan and exerts a great impact on regional water cycles and climates. This study has used reflectivity data observed by the TRMM precipitation radar for the first time to explore diurnal variations of the Meiyu/Baiu rain belt and their relations to diurnal variations of rainfall on both sides of the frontal zone. The data period was June-July of 1998-2005. A front-relative coordinate system has been designed to make the analysis of the diurnal cycle of the Meiyu/Baiu rain belt feasible. It is found that a remarkable diurnal cycle of reflectivity that peaks in the early morning exists in the frontal zone. On the other hand, a distinct diurnal cycle of reflectivity with an opposite phase that peaks in the late morning and afternoon is observed both south and north of the frontal zone. There exists significant eastward propagation of diurnal signals from about 115E to 140E. The propagation speed of minimum/maximum reflectivity in the frontal zone is similar to that of maximum/minimum reflectivity both south and north of the frontal zone. At each longitude, the formation of maximum/minimum reflectivity in the frontal zone follows the building of minimum/maximum reflectivity on both sides of the frontal zone. Early morning maximum reflectivity developing in the frontal zone also propagates northeastward, which contributes to the second peak of reflectivity observed north of the frontal zone. The analyzed results imply that the thermally forced diurnal evolution of rainfall systems on both sides of the Meiyu/Baiu frontal zone would have exerted a great regulation on the diurnal cycle of the Meiyu/Baiu rain belt.

Keywords: diurnal variation, meiyu baiu rain belt, trmm

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JMS009 **Oral Presentation** **926**

The influence of the NAO on oceanic precipitation variability

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Phillip Arkin

North Atlantic Oscillation (NAO) related precipitation anomalies have been widely documented to affect significantly wintertime, and to some extent, spring precipitation in the European and Middle Eastern regions. However the impacts of the NAO on global oceanic precipitation and the associated atmospheric circulation anomalies have not yet been fully described. The main goal of this work is to advance the current understanding of the precipitation variations over the global oceans related to the NAO on interannual time scales over the period 1979-2002. Among the open science questions which will be discussed: what are the robust features of the NAO related oceanic precipitation anomalies and what are the main mechanisms? Are there asymmetries in the high/low NAO phase precipitation anomalies and what causes them? Is there a significant coupling between the NAO and tropical precipitation variability? What are the implications of the observed precipitation anomalies for the oceanic water budget? The investigation will use multiple state-of-the-art global precipitation datasets and re-analyses. In order to assess the robustness of the precipitation features, observed anomalies will be substantiated by the investigation of the associated anomalous circulation

Keywords: nao, oceanic, precipitation

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JMS009 **Oral Presentation** **927**

Estimation of Snow Accumulation and Precipitation in Antarctica Using Automated Acoustic Depth Gauges

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Antarctica is a continent of many meteorological unknowns, the most significant of which is the temporal and spatial distribution of precipitation. The importance of quantifying Antarctic precipitation for purposes of understanding the global hydrological cycle cannot be overstated; however, accurate measurements of precipitation are not available at this time. Traditional methods of quantifying precipitation, such as estimates from microwave sounders, snow gauges, or radar are not feasible or not available in Antarctica at the present time. Consequently, the amount of accumulation at a given site, whether by blowing snow or falling precipitation, remains largely unknown. Acoustic depth gauges (ADG) provide the only concrete real-time information for accumulation in Antarctica. However, ADGs only measure snow depth change, and not precipitation. The real issue is deriving how much precipitation is a factor in changes of snow depth observed from the acoustic depth gauges. The focus of this project is to evaluate the usefulness of continuous automated snow depth measurements for the purpose of measuring precipitation. There are two specific goals of this work 1) to determine if the accumulation of snow at a given observation site is significantly affected by the horizontal transport of snow; and 2) to determine if measurements of snow depth change are sufficient to define precipitation patterns. This project, lasting from 2003-2006, resulted in the placement of eight ADG sensors mounted on board automatic weather stations (AWS) at several locations across Antarctica. Using information from the AWS, ADG, and other measurements collected, preliminary studies on expected causes of accumulation at each station was conducted. For some events, causes of snow depth change were able to be determined, but for most events, the causes of snow depth change were unknown. The results suggested that observation of snow depth change alone was not sufficient to determine precipitation. However, closer examination of the measurements suggested that when depth observations were combined with other measurements, the potential exists to accurately estimate the precipitating snow contribution to depth change.

Keywords: accumulation, precipitation, antarctica

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JMS009 **Oral Presentation** **928**

A Comparison of CloudSat Cloud Radar Observations with Simulated Cloud Radar Output from the Multiscale Modeling Framework Global Climate Model

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Launched in late April 2006, the NASA CloudSat mission uses a near nadir-pointing millimeter-wavelength radar to probe the vertical structure of clouds and precipitation. The CloudSat radar has a vertical range resolution of approximately 480 m. The minimum detectable signal is still being evaluated, but early results show that it is slightly exceeding expectations with a sensitivity of about -30 dBZ throughout the troposphere. This combination of sensitivity and resolution is not sufficient to detect all clouds (Stephens et al. 2002, Marchand et al. 2007). It is therefore critical when comparing CloudSat observations (or retrievals) with model output to account for the radar detection limits. Over the last few years a new type of global climate model (GCM) has emerged in which a two-dimensional or small three-dimensional cloud-resolving model (CRM) is embedded into each grid of a GCM. The embedded CRM removes the need for most of the cloud parameterizations used in traditional GCMs. This new approach is frequency called a Multiscale Modeling Framework (MMF) or super-parameterization. Here we present a comparison of MMF output and CloudSat radar observations. We account for the radar detection capabilities by simulating the 94 GHz radar reflectivity that CloudSat would observe from the high-resolution cloud-resolving model output produced by the MMF.

Keywords: cloudsat, multiscale modeling framework, instrument simulator

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JMS009 **Oral Presentation** **929**

Precipitating and non-precipitating clouds over Tropics and Subtropics

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Clouds are known to have important impacts on the balance of energy and hydrology in the Earth-Atmosphere system due to their interactions with solar and terrestrial radiation. To make clear the global macrophysical and microphysical characteristics of clouds for understanding effects of various cloud types on Earths energy balance and their potential impacts on climate change, the International Satellite Cloud Climatology Project (ISCCP) has delineated global clouds based on measurements from imaging radiometers aboard a series of operational weather satellites for more than two decades. However, precipitating clouds, as one special cloud type, cannot be separated effectively from the cloud ensemble in ISCCP due to the inability of infrared/visible observations to identify instantaneous precipitation from clouds, thus leading to ambiguities when the particular properties of precipitating clouds are taken into account. To address differences between precipitating clouds and non-precipitating clouds, occurrence frequency, diurnal cycle, optical thickness for the two cloud types are investigated based on the identification of precipitating clouds from non-precipitating clouds measured by TRMM PR. Properties derived from VIRS are analyzed separately for the both cloud types. Results are found that precipitating clouds amount is only ~4.0 over the tropics and subtropics, which is less than 7.7% to the cloud total. Spatial distributions are exposed that both types are consistent well except for specific regions prevailed by maritime stratocumulus. However, diurnal cycles indicate significant dissimilarities for both cloud types especially over ocean. The retrieved cloud properties show distinct differences of cloud top temperature (CTT), cloud top pressure (CTP) and cloud optical thickness (COT) between precipitating clouds and non-precipitating clouds. Statistics indicates non-precipitating clouds exhibiting itself as middle clouds with COT less than 10 over both ocean and land. On the contrary, precipitating clouds over both ocean and land fall into the category of high cloud with significantly large COT. According to the ISCCP cloud classification based on CTP and COT, cumulus, stratocumulus, altocumulus, and cirrus are the four predominant non-precipitating clouds categories. Most precipitating clouds have high cloud tops and moderate or large COT. Deep convective cloud and cirrostratus cloud are the first and second primary precipitating clouds over ocean and land. Such pseudo-cirrostratus cloud may be deep convective or stratiform precipitating clouds that do not satisfy the definition of ISCCP cloud classification, which implies a considerable amount of precipitating clouds misclassified as cirrostratus using ISCCP criterion.

Keywords: precipitation, trmm, isccp

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JMS009 **Oral Presentation** **930**

Satellite Evidence of Acceleration of the Hydrologic Cycle

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Climate models and satellite observations both indicate the total amount of water in the atmosphere will increase substantially due to global warming at a rate of 7% K-1. This increase is dictated by the Clausius Clayperon relationship under the condition that the atmospheric relative humidity stays constant. However, climate model simulations from the Coupled Model Intercomparison Project predict global precipitation will increase at a much slower rate of 1-3% K-1. A subdued response of precipitation to global warming predicted by the models has implications for the global circulation. Here we analyze variables related to the hydrological cycle observed with the Special Sensor Microwave Imager (SSM/I) dataset. The recently released SSM/I version 6 has been carefully calibrated to remove intersatellite offsets and instrumental drifts, therefore is suitable for climate studies. SSM/I simultaneously measures precipitation, water vapor, and surface wind stress over the ocean, which we then use to compute evaporation. Our analysis of the 1987-2006 timeseries of satellite observations does not support the models prediction of a muted response of precipitation to global warming. Rather, the observations suggest that precipitation, evaporation, and total atmospheric water have increased at about the same rate over the last two decades. The observations also show a slight increase in ocean surface winds (about 1% decade-1), in contrast with model predictions.

Keywords: precipitation trend, global warming, surface wind

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JMS009 **Oral Presentation** **931**

Climatic change effects on groundwaters in Milano and Lodi provinces.

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This study is a part of the Regional Impact of Climatic Change in Lombardy Water Resources: Modelling and Applications (RICLC-WARM) project. This project is based on the analysis of the integrated hydrologic cycle, in the river Adda basin. The match is to develop a methodology to a sustainable management of water resources in a very highly populated and industrialized area. Concerning groundwater, study has been focused on Milano and Lodi provinces. Piezometric levels, hydrometric levels and pluviometric data have been collected. Piezometric data are recorded by a dense groundwater quantitative monitoring network. Its constituted by nearly 145 wells and its been working since 1979; piezometric levels are on a monthly base. Instead hydrometric and pluviometric data are registered by manual and mechanic stations distributed within the considered provinces and neighbouring areas. This data set has allowed a spatial and temporal analysis of the uppermost unconfined aquifer of Lombardy aquifer system. First of all, a temporal trend analysis has been carried out; long series of piezometric data (1979-2005) have been compared with hydrometric and pluviometric data sets. This comparison, developed also using index such as SPI (Standardized Precipitation Index), has highlighted correlation or not correlation between superficial waters and groundwater and the most important extreme climatic events (drought or flooding) and groundwater. Later, piezometric levels and hydrometric levels of the most important rivers have been elaborated with geostatistical techniques, taking into account the hydrographic network. Piezometric countour maps have been obtained in order to put in evidence differences in the water table levels, on a yearly and seasonal base, to underline the presence of a spatial trend. The project aims to evaluate impacts on groundwater in critical situations, connected with agricultural system, for different climatic conditions and hydrogeological characteristics.

Keywords: groundwaters, lombardy, riclic

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JMS009 **Oral Presentation** **932**

Trends and uncertainties in coupled model simulations of the hydrological cycle

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Changes in the hydrological cycle induced by global warming may have more climate impact on human society than the warming itself. However, projected changes in the hydrological cycle have large uncertainties due to the very complex nature of the processes involved in it. Insufficient observations also hamper a realistic estimate of the global hydrological sensitivity and historical changes. We exploit this issue in ensembles of coupled climate model simulations with 'perturbed physics' for the 20th and 21st centuries. We aim to identify emerging trends and to quantify the associated uncertainties at various temporal and spatial scales with different components within the hydrological cycle.

Keywords: hydrological cycle, coupled modelling, uncertainty

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JMS009 **Oral Presentation** **933**

The Influence of the Large-Scale Meridional Sea Surface Temperature Curvature on Tropical Circulation Regimes

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In this paper we show how the large-scale meridional curvature of the sea surface temperature (SST) influences the general circulation in an earth-type aqua-planet atmosphere. Three circulation regimes can be distinguished. For SST distributions with strong curvature one gets a single narrow intertropical convergence zone (ITCZ) at the maximum of temperature. The maximum of latent heat flux coincides with the convergence zone. For SST distributions with intermediate curvatures a single broader meandering ITCZ forms at the maximum of temperature. In this case the maximum of latent heat flux is outside the ITCZ and the dynamics is determined by moisture convergence. Flattening the SST distribution further a transition occurs to a circulation regime with two ITCZs not coinciding with the maximum of temperature and straddling along the equator. The convergence zones are weak and intermittent and the maximum of latent heat flux is shifted poleward. In addition the spatial organization and dynamics of convective structures strongly depend on the large scale SST curvature. Large curvatures around the temperature maximum favour thin zonally aligned banded structures. Small curvatures around the temperature maximum favour patch-like intermittent structures in a broad region with an increased tendency of tropical cyclone formation. The transition between the single and double ITCZ regime occurs for SST distributions which are close to the SST distributions presently observed. The transition is accompanied by drastic global-scale changes in the atmospheric response and seems therefore also relevant for the present climate. Dynamically it is very interesting that near the critical curvature the single and double ITCZ circulation regimes can exist both for the same SST distribution. Complex non-local feedback mechanisms between planetary boundary layer and global circulation lead to this multi-equilibrium state. Finally we derive criteria for the transition between the single and double ITCZ-regime using a simple vanalytical zonally symmetric model with concentrated convective zones. The model is based on angular momentum and temperature homogenization within the Hadley cell.

Keywords: aqua planet, itcz, tropics

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JMS009 **Oral Presentation** **934**

The role of moisture recycling evaluated by using stable isotope data over the central Tibetan Plateau during the monsoon season

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Both meteorological data and stable isotope data were used to investigatio the role that moisture recycling plays in maintaining moist land surface conditions over the middle of the Tibetan Plateau during the summer monsoon season. Past studies have shown that precipitation events of the summer monsoon season can be categorized according to synoptic conditions as east-migrating trough types, heat low types, and regional circulation types. Precipitation events during an intensive observation period from August 13 to August 27, 2004 were therefore classified into these three types. Contributions of recycled moisture in each precipitation types were investigated using isotopic features. The isotope data include precipitation, near-surface atmospheric moisture, and evapotranspiration. By using a simple one-dimensional cloud model, the isotopic content of atmospheric moisture formed precipitation was estimated from observed precipitation isotope data, and then simulated values were then compared to observed isotope data for the lower atmosphere. The simulated large isotopic depression that accompanied trough-type precipitation did not match the observed counterpart, suggesting that trough-type precipitation largely consists of moisture advected from surrounding areas into middle level of atmosphere. For other precipitation types, however, isotopic variations in the simulated precipitation source neatly corresponded to those of atmospheric moisture; this matching reflects the isotopic variations of evapotranspiration. Recycled moisture thus plays an important role in precipitation associated with heat lows and regional circulations. Regional circulations typically occur when synoptic-scale winds are weak, and the increased isotopic variation while reginal circulation was active can be explained by an increase from 30% to 80% in the contribution of recycled moisture having relatively heavy isotopes. Repeated moisture recycling linked to regional circulations contributes to maintaining moist land surface and is responsible for the daily precipitation during this period.

Keywords: tibet, recycling, isotope

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JMS009 **Oral Presentation** **935**

Diurnal and seasonal variation of rain events over different geogrphical stations over Kerala, India

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Rain events and their frequency of occurrence are important in various applications such as hydrology, space physics, radio refractive studies, etc. Kerala is a narrow state stretching along the west coast from the southern tip of India to the north up to 580 km while the width of the state varies between 35 to 120 km from the Arabian Sea in the west to the western Ghats in the east. It has different topography which includes coastal, midland and high land stations. The climatology and thus the rainfall pattern differs with topography. The state is enriched with southwest monsoonal rainfall and is about 71 % of the annual rainfall. The average annual rainfall of Kerala is about 300 cm, with more than 500 cm in certain elevated stations. The total annual rainfall in the state differs from 380 cm over the extreme northern parts to about 180 cm to the south. In the southern region, the contribution of rainfall during the monsoon is around 40-50 % and in the northern areas it is around 80%. Here, we examined the temporal and spatial variation of the rainfall events in different time scales over coastal, midland and high land stations. The hourly rainfall data over different locations were procured from the hydrology department. To understand the seasonal and diurnal variation of rainfall over the three different geographical regions, we carried out analysis over the representative stations in north and middle Kerala. In the north Kerala coastal station, more number of rainy days are found in the monsoon season. More rain events around 12 numbers are found to occur between 10 to 12 hours (IST) in the month June. Over this station, more events are seen during southwest monsoon season. In the middle land, the bimodal variation is seen on an annual basis and they are in the southwest monsoon and northeast monsoon seasons. Here, the maximum rain occurrence is seen in the wee and late evening hours. Over the high land, the bimodal distribution is found; both occur in the southwest monsoon itself. The diurnal variation of the rain events is seen in the day hours (maximum occurrence between 12 to 16 hours during June month and 7 to 12 hours during August). Over mid Kerala station, bimodal rainfall pattern is found, one is in the monsoon season and the rain events are almost uniformly distributed all over the monsoon months. The second mode is found in the October. The midland station shows similar pattern of the coastal station, but the diurnal pattern differs. For the high land, the frequency of rain occurrence is less than that of the coastal and midland stations because the station is situated in the rain shadow region. It is interesting to note that this station exhibits three modes in the seasonal pattern during March, July and November. The frequency of the rain events is high during November. In all the three modes the diurnal feature is almost same.

Keywords: rainevents, diurnalvariation, seasonalvariation

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JMS009 **Oral Presentation** **936**

The heat flux during the pre-monsoon period over the Indochina Peninsula

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The heat flux during the pre-monsoon period over the Indochina Peninsula was investigated using the reanalysis daily data and the observational data in 2003. Using the criteria of the monsoon onset decision by the lower zonal wind (700 and 850 hPa layer), the date of the monsoon onset in 2003 is 13th May in the inland area of Thailand. In order to validate the heat flux from the land surface of the reanalysis data, we use the observational data at TFM during January to June in 2003. We segment the inland area of Thailand into 3 regions. Each region are named region A (12.5-17.5 N, 97.5-100 E), B (12.5-17.5 N, 100-102.5 E), and C (12.5-17.5 N, 102.5-105 E). It is shown that the dominance of the latent heat fluxes in regions B and C are longer than that in region A. In order to reveal such long dominance of the latent heat flux during the pre-monsoon season, we calculate the area-average of the latent heat flux in the inland region of Thailand (regions B and C). According to the time series of the latent and sensible heat flux in the inland region of Thailand from January to June in 2003, We can see that the continuous dominance of the latent heat flux starts from middle March before the monsoon onset date. It is clarified that the land surface is already wet before that the strong convection starts by the monsoon onset. Moreover, we can see that the latent heat flux is intermittently dominant from middle February. It is suggested that the intermittent rainfall events during the pre-monsoon season drastically change the condition of the land surface. In order to reveal the relationship between the intermittent rainfall events and the heat flux from the land surface during the pre-monsoon season, we carry out the composite analysis during the pre-monsoon period in 2003. The dry period and the wet period are from 29th January to 11th February (period A) and from 12th February to 2nd March (period B), respectively. According to the composite map of the latent heat flux (lE) and sensible heat flux (H) from the land surface during the period A in 2003, we can see that the land surface in the inland region of Thailand during the dry period is very dry same as that in India and Myanmar. On the other hand, the latent heat flux is dominant during the wet period in the southern part of China, Laos, and the eastern part of Thailand. According to the composite analysis of the upper wind field (300 hPa layer), the positive vorticity is located around the inland region over the Indochina Peninsula during the period B in 2003. We can see that the precipitable water in the inland area of Thailand increases during the period B. It is suggest that the latent heat flux from the land surface make atmosphere on the land moistness.

Keywords: rainfall, land atmosphere interaction

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JMS009 **Oral Presentation** **937**

A recent drought over the canadian prairies and its associated storms

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The Canadian Prairies is a large region of central Canada and it is the largest agricultural region in the country. This region suffered a severe drought from 1999 into 2005 which was one of the worst in Canadian history. From a global perspective, this drought, which also affected western United States and parts of Mexico, represented one of the most persistent precipitation deficits in the world. From a regional perspective, the core of the drought in Alberta was maintained over the several year period despite varying large scale forcing, substantial water vapour input, and the common occurrence of clouds and precipitation aloft. Locations farther from this core were also subjected to drought but they were occasionally buffeted by torrential rainfall in summer and major snowstorms in winter. The intensity of some of these storms was actually intensified because of the dry drought environment in which the rapid evaporation of precipitation aloft occurred, leading to enhanced downdrafts that elsewhere triggered intense updrafts. In terms of precipitation, the drought over the Prairies approached a regional climate system in which persistent dryness is only interspersed by catastrophic storms. Use is made of numerous satellite, model and in-situ products to characterize the cycling of water during this drought and to explain its behaviour with a particular emphasis on the storms occurring within the drought period.

Keywords: drought, canada, storms

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JMS009 **Oral Presentation** **938**

THe relationship between a negative SST anomaly over the Subtropical Central South Atlantic and the active phase of the SACZ

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We examined variability of the air-sea coupling system associated with the intraseasonal changes in the South Atlantic convergence zone (SACZ). In the present study, composite fields were analyzed for the active phase of the SACZ. A region with low sea-surface temperature (SST) was detected over the subtropical central South Atlantic when the SACZ was active. The low-SST region was located east of the SACZ. By examining the sea-surface wind anomaly, an anticyclonic circulation and a horizontal divergence were identified over this low-SST region, while a cyclonic circulation is observed in the precipitation zone associated with the SACZ. The surface wind flows into the precipitation zone from the low-SST region. It appears that the surface wind form the low-SST region contributes to the convergence in the SACZ. By analyzing lag composites for day -10, it was revealed that the negative SST anomaly east of the SACZ appeared prior to the active phase of the SACZ. At this time, no significant outgoing longwave radiation (OLR) anomaly was detected just over the cold SST. It is suggested that the anomalous SST is not a result of the convective activity associated with the SACZ. Such a negative SST anomaly was not observed for the South Pacific convergence zone (SPCZ).

Keywords: sacz, subtropical convergence zone, air sea interaction

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JMS009 **Oral Presentation** **939**

Large-scale, coherent rainfall systems, the Madden-Julian Oscillation, and flow volumes in Australia's Murray-Darling Basin

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Large-scale convective systems may propagate long distances while maintaining statistically coherent structures. Time-series measured at distinct spatial locations may be compared through cross-spectral coherence analyses to characterise their spectral similarities. We present a methodology for extending coherence analyses across large spatial regions, to generate spatial maps of coherence. There are three independent variables that are used to generate maps: the distance over which cross-spectra are calculated, and lower and upper limits of spectral period. Image-processing techniques are applied to the spatial patterns of these maps, yielding an overall measure of seasonal coherence for each combination of independent variables. These techniques are used to provide a spatially and temporally explicit characterisation of the Australian summer monsoon. The monsoon spawns large-scale convective systems that commonly propagate south-east into the interior of the continent, carrying rain to these otherwise arid regions. The Australian continent is largely flat, with deep, heavily weathered soils that promote infiltration. This leads to a considerable (but variable) lag or disconnection between precipitation and stream flow. This disconnection is exacerbated by the extensive extraction and/or retardation of river flows for agricultural purposes. In such systems, precipitation may be more effectively conveyed along river systems through the propagation of coherent convective systems, rather than in-stream transport alone. Although rainfall aggregated over a range of scales is strongly related to corresponding flow volumes, this relationship is largely independent of the spatial scale of aggregation. Not only are the spatially explicit coherence analyses described above equally strongly related to overall volumes of stream flow, but the strength of relationship is explicitly dependent upon both spatial and temporal scales. This enables the broad identification of the spatial and temporal scales over which coherent convective systems maximally transfer precipitation to hydaulic response within this landscape. These coherence analyses are further related to the Madden-Julian Oscillation. This global climate cycle is a defining feature of the Australian monsoon, and is known to enhance the activity of transient, extra-tropical convective systems of the kind described above. The spatial and temporal scales referred to above are strongly related to the scales of extra-tropical systems promoted by the Madden-Julian Oscillation. The development of this connection provides an explicit description of the dynamics of connection between a global, equatorial climatic cycle, the large-scale precipitation systems it spawns, and a corresponding hydraulic response within one of the planet's most meteorologically and hydrologically variable regions.

Keywords: coherence, madden julian

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JMS009 **Oral Presentation** **940**

Simulations and observations of multiple scattering effects in space-borne radars when observing precipitation systems

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Recent work has highlighted the importance of multiple scattering effects when dealing with high frequency space-borne radars in configurations like those planned or employed for the GPM, the CloudSat, and the EarthCare missions. The first images delivered by the 94 GHz Cloud Profiling Radar on board of CloudSat when passing precipitating systems provide distinctive signatures of multiple scattering effects (e.g. no 'discontinuity' peak in the reflectivity signal at the surface range, long tails in the reflectivity profiles at apparent ranges below the surface). A numerical model based on the Monte Carlo solution of the vector radiative transfer equation has been developed to simulate radar signals. Except for contributions due to the backscattering enhancement, the model is particularly suited for evaluating multiple scattering effects. The model accounts for general radar configurations such as airborne/space-borne/ground-based, monostatic/bistatic, and includes the polarization, the antenna pattern and the interaction with a Kirchoff surface as particularly relevant features. Multiple scattering effects in co- and cross-polar radar returns are evaluated for realistic vertically inhomogeneous scenarios involving rainfall, snow, graupel, and ice crystals extracted from cloud resolving model simulations for space-borne and air-borne configurations. Results show that the multiple scattering enhancements become a real issue for space-borne Ka band radars for medium to heavy precipitation and for W band radars already in the presence of light precipitation. Multiple scattering effects can reach several tens of dB when heavy cold rain systems are considered, i.e. when the profiles include rain layers with a high density of ice particles aloft. Multiple scattering effects are, however, highly dependent on the ice layer of the cloud and on its microphysical assumptions (e.g. large ice particles strongly enhance multiple scattering). For some of the simulated profiles, reflectivities display no discontinuity at the surface range and long signal tails at ranges below the surface range in accordance with Cloudsat observations. When the cross-polar returns are analyzed, high LDR values appear both in space-borne and air-borne configurations. The LDR signatures are indicators of multiple scattering effects since they cannot be explained by single scattering computations even including non-spherical particles.

Keywords: multiple scattering, radar, precipitation

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JMS009 **Oral Presentation** **941**

Regional Water Vapor sources for the Euphrates-Tigris watershed

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Given the massive changes in land cover occurring in the Middle East there is potential for significant feedbacks on the regional atmospheric circulations and precipitation. This study attempts to quantify the importance of different parts of the region to the production of precipitation in the Euphrates-Tigris watershed. A back-trajectory model is run to calculate the spatial water vapor contributions to the 300 largest precipitation events occurring from 1999 through 2004. The input data for the back-trajectory model is supplied by an MM5 simulation over the region. The method allows quantitative estimates of within watershed precipitation recycling as well as the water vapor contributions from surrounding land areas and large water bodies.

Keywords: back trajectory, recycling, sources

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JMS009 **Oral Presentation** **942**

Conditions associated with deep convection and precipitation over Africa

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Long-term statistics of organized convection are vital to improved understanding of the hydrologic cycle at various scales, especially in Africa, where precipitation variability has dramatic social impact. The timing and duration of precipitation events can be examined systematically through the diurnal cycle. This study is focused on the diurnal cycle and propagation characteristics of deep convection and associated precipitation across sub-Saharan Africa and mid-latitude southern Africa. Reduced-dimension techniques are used to determine the propagation characteristics of cold clouds, which are then compared with those of other continents. Large-scale influences are diagnosed from global analyses. It has become increasingly evident that organized convection provides a sizeable fraction of warm season continental rainfall as reported by Carbone et al. (JAS 2002). Organized convection appears as coherent sequences or episodes of convection. Warm season convection also exhibits coherent behaviour as diagnosed from cold clouds over , , and Europe. Deep convection over Africa displays the following traits: It is understood that moist air with moderate convective available potential energy (CAPE) is necessary to sustain deep moist convection. CAPE generation is often associated with the flow and convergence of moist energetic air from the equatorward direction. When the supply of moist, energetic air is disrupted then convection does not organize into propagating, convective systems. This is commonly observed in subtropical and mid-latitude southern Africa. The presentation will illustrate specific examples of the influence of large-scale environments on the organization and propagation of deep convection and associated rainfall in Africa. References Carbone, R.E., J.D. Tuttle, D. Ahijevych, S.B. Trier, 2002: Inferences of predictability associated with warm season precipitation episodes, J. Atmos. Sci., 59, 2033-2056. Laing, A. G. and J.M. Fritsch, 1997: The global population of mesoscale convective complexes. Q. J. R. Meteorol. Soc., Jan B, 123, 389-405.

Keywords: precipitation episodes, warm season convection, africa

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JMS009 **Oral Presentation** **943**

Internal structure of westward migratory cloud systems with diurnal cycle over Sumatera Island during HARIMAU2006 campaign

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IORGC JAMSTEC

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A diurnal cycle of systematic migration of cloud systems exists over the entire Sumatera Island (about 1,500 km in length) in Indonesia (Mori et al. 2004; Arakawa and Kitoh 2005; Sakurai et al. 2005). The cloud systems develop in a mountainous area in the afternoon and migrate westward and/or eastward for several hundred kilometers (about 500 km) from midnight to morning. The internal structure and its process of the cloud systems with diurnal cycle were investigated by dual-Doppler radar analysis in order to understand the mechanisms of the diurnal cycle. Three-dimensional distribution of precipitation in the western part of Sumatera Island was obtained by Hydrometeorological ARray for ISV-Monsoon AUtomonitoring (HARIMAU) 2006 campaign. Westward migration of cloud systems with diurnal cycle was observed on 10 November 2006. Convection got active in the mountainous area around 11 LST, and organized into precipitation systems with a horizontal scale of several tens of kilometers. The precipitation systems migrated westward at a speed of 5 m/s (16 LST). Background wind observed by sounding was southerly below 1 km in height, easterly at a speed of 5 m/s between 1 and 7 km in height, and northeasterly above 7 km in height. The precipitation systems developed again over the sea off the western coast of Sumatera Island and became bigger than those over the land. The horizontal scale of the precipitation systems was 100 km in long axis which was on a parallel with the west coast line of Sumatera Island. Internal structure of the precipitation systems consisted of convective area which developed up to 16 km in height in the leading edge of the precipitation systems and stratiform area with updraft up to 12 km in height with a horizontal scale of 20 km in the rear of the leading edge. Downdraft was observed below 2 km in the leading edge of the precipitation systems. A storm-relative inflow turned to updraft above a gust front derived from the downdraft. It is considered that the inflow played an important role in the maintenance of the precipitation systems as a water vapor supply to the precipitation systems and the precipitation systems were migrated by background wind in the middle troposphere.

Keywords: diurnalcycle, mcs, harimau

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JMS009 **Oral Presentation** **944**

Wintertime Lake-Effect Snow in the Great Lakes Region of North America

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Cold season precipitation in the Great Lakes region of North America is strongly influenced by the open waters of the five major lakes. This effect is seen not only in the modulation of synoptic scale systems crossing the region but also in the formation of localized intense snow squalls due to the strong land-water temperature contrast. A comprehensive program to better understand the precipitation development in these lake-enhanced systems and their role in the regional hydrology was undertaken during the winter of 2006/07. The project involved flights by a research aircraft into these systems as well as the deployment of specialized ground-based equipment to a site to the lee of one of the Great Lakes. The instrumentation on the aircraft included a full suite of in-situ cloud and precipitation sensors. Also on the aircraft was a nadir-zenith pointing Ka-band radar. The enhanced measurement site (CARE) had the following instrumentation: a vertically pointing X-band radar, a scanning dual frequency (Ka-Ku-band) radar, a scanning dual-polarized C-band radar some 30 km away, a profiling microwave radiometer, and a variety of in-situ precipitation sensing devices. Three successful missions were flown into these lake-enhanced systems. Measurements during the entire winter at CARE provided a seasonal perspective on these systems. The presentation will give an overview of the data collection. Aircraft measurements highlight the microphysical mechanisms that create such high precipitation efficiency. Challenges in the quantitative measurements of snowfall amount from such localized systems by weather radar are discussed. This includes both ground-based measurements and space-based measurements from satellites such as CloudSat and the upcoming GPM mission. Modelling of selected cases by MM5 is used to better assess the implications of these localized but intense storms on regional hydrology.

Keywords: winter, canada

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JMS009 **Oral Presentation** **945**

Climate Simulation of Continental and Oceanic Water Sources for Large River Basin Precipitation

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An atmospheric general circulation model simulation for 1948-1997 of the water budgets for the MacKenzie, BALTEX, Mississippi and Amazon River basins is presented. In addition to the water budget, we include passive tracers to identify the geographic sources of water for the basins, and the analysis focuses on the mechanisms contributing to precipitation recycling in each basin. While each basins precipitation recycling has a strong dependency on evaporation during the mean annual cycle, the interannual variability of the recycling shows important relationships with the atmospheric circulation. The MacKenzie River basin recycling has only a weak interannual correspondence with evaporation, where the variations in zonal moisture transport from the Pacific Ocean can affect the basin water cycle. The BALTEX region shows some correlation between low North Atlantic evaporation and high local recycling ratios. In general, BALTEX and MAGS show similar characteristics in recycling ratios. On the other hand, the Mississippi River basin precipitation and recycling have strong interannual correlation on evaporation. The evaporation is related to moist and shallow planetary boundary layer that provides moisture for convection at the cloud base. At global scales, high precipitation recycling is also found to be partly correlated to warm SSTs in the tropical Pacific Ocean. The Amazon River basin evaporation exhibits small interannual variations, so that the interannual variations of precipitation recycling are related to atmospheric moisture transport from the tropical south Atlantic Ocean. Increasing SSTs over the 50-year period are causing increased easterly transport across the basin. As moisture transport increases, the Amazon precipitation recycling decreases (without real time varying vegetation changes). In addition, precipitation recycling from a bulk diagnostic method is compared to the passive tracer method used in the analysis. While the mean values of the different recycling methods are different, the interannual variations are comparable between each method. The methods also exhibit similar relationships to the terms of the basin scale water budgets.

Keywords: recycling, agcm, hydroclimate

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JMS009 **Oral Presentation** **946**

Global Distribution of Precipitable Water, Saturated Precipitable Water, and Relative Precipitable Water as Derived from Observational and Reanalysis Data Sets

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Water vapor in the atmosphere plays an important role in the earths climate system. We analyze precipitable water (water vapor content contained in a column of unit cross section extending all of the way from the earths surface to the top of the atmosphere) for the purpose of understanding behaviors of the water vapor in the atmosphere. We use monthly mean precipitable water from observation-based NVAP data and from observation & numerical weather prediction model-based JRA25, ERA40, R2 reanalysis meteorological data for 12 years from January 1988 to December 1999. We calculate saturated precipitable water from air temperature data at tropospheric pressure levels using JRA25 data. We divide the precipitable water (PW) by the saturated precipitable water (SPW) to obtain relative precipitable water (RPW), which might be introduced firstly in this study. SPW and RPW are equivalent to saturated water vapor and relative humidity, respectively, of the atmospheric column. SPW is a theoretical quantity determined by thermodynamic factors. RPW, interpreted as water retentivity of the atmospheric column, is the quantity determined by not only thermodynamic factors but also dynamical factors such as atmospheric circulation. The results are as follows: (a) 12-year averaged global means of PW, SPW, and RPW are approximately 24.7 mm, 41.5 mm, and 59.5%, respectively. (b) As for12-year averaged global distribution, PW is large around the equatorial regions, especially intertropical convergence zone (ITCZ) and south Pacific convergence zone (SPCZ). SPW is large around the equatorial regions, especially the western Pacific Ocean, the Bay of Bengal, the Arabian Peninsula, and the central part of Africa. RPW is large around the equatorial regions, especially ITCZ and SPCZ while low in the Arabian Peninsula, Sahara, Australia, and the west coasts of California and Peru. (c) The year 1998 among the 12 years from 1988 to 1999 shows the following characteristics associated perhaps with the strong El Nino from 1997 extending through 1998. PW is large around the eastern Pacific equatorial region, the Indonesian Islands, while small between the equator and 15 degrees north in the Pacific Ocean, the global mean PW showing the maximum among the 12 years. SPW is large between 30 degrees south and 30 degrees north, the global mean SPW showing the maximum among the 12 years. RPW is large around the eastern Pacific equator, the Indonesian Islands, while small between the equator and 15 degrees north in the Pacific Ocean. The global mean RPW, i.e., the water retentivity of the whole atmosphere of the earth, is almost constant throughout the 12 years including 1998 as far as annual mean is concerned.

Keywords: retentivity, water, vapor

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JMS009 **Oral Presentation** **947**

Characteristics of the tropical rainfall revealed in the TRMM, GPCP, ANS NCEP reanalysis data sets

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A set of global, daily rainfall products has been intercompared to understand the characteristics of tropical rainfall and investigate the quality and utility of the estimates. These are the latest Tropical Rainfall Measuring Mission (TRMM) rainfall data retrieved from TRMM satellite only, the Global Precipitation Climatology Project (GPCP) data, which blend satellite data and rain gauge measurements, and the National Centers for Environmental Prediction (NCEP) reanalysis data from the forecast of the assimilated model. In addition to these rainfall data, the outgoing longwave radiation (OLR) data from the TRMM satellite and the National Oceanic and Atmospheric Administration (NOAA) polar-orbiting satellite are used to investigate the relationship between the OLR and rainfall. The comparisons between data sets are made in terms of description of long-term mean, latitudinal and annual variation, and correlation. All data sets have similar statistical features including mean and regional variations, but they are different in amplitude and at smaller geographical scales. The TRMM and GPCP data are much more consistent in space and time when compared with the NCEP rainfall data. Computation of continuous statistics shows that average bias among data sets is large along the Intertropical convergence zone (ITCZ) regions with intense rainfall bands, whereas both data sets have consistent variations over the subtropics. The differences between the TRMM and GPCP come from the usage of the TRMM precipitation radar (PR) data, unique sampling of the TRMM satellite, and inclusion of gauge measurements in GPCP calibration. Correlation coefficients between the TRMM and GPCP rainfall, however, are dependent on the territorial features: larger over the oceans where the GPCP rainfall is retrieved mainly from satellite data in spite of not from TRMM satellite, and smaller over lands where the GPCP rainfall is merged with rain gauge data.The NCEP data, when compared with other data sets, suffer from the large discrepancies around tropical rainy region including the ITCZ and the South Pacific convergence zone (SPCZ) where are data-poor regions and critically affected by the quality of assimilation procedures. These discrepancies primarily result from that the NCEP underestimates the intraseasonal variations and poorly represents the seasonal transition of the major convective band across the equator around the warm pool regions. The relationships between the OLR and rainfall are highly complicated with respect to location and time, but some regions with dominant convective activities show a relatively high correlation between the OLR and rainfall. The similarity between the GPCP and TRMM rainfall gives great confidence in the quality, whereas the users for the NCEP reanalysis rainfall data should remind the difference with the others. At the same time, more rigorous studies for characterizing the errors in each data set as well as to get a reliable data in quality and quantity from more advanced sensors are important to utilize new data fully and to find a useful connection with established data set.

Keywords: intercomparison, trmm, gpcp

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JMS009 **Oral Presentation** **948**

Precipitation modeling of the Yellow River basin using WRF model

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To evaluate the change of water resources over the Yellow River basin, an examination of precipitation was carried out using the Weather Research and forecasting (WRF) model over the Yellow River domain from 1980 to 1997. The results show that the inter-annual variations of precipitation could be represented compared with a dataset based on gaugedata at four watersheds over Sanmenxia. The simulated precipitation at two atersheds in upper reaches is in agreement with observed values. There is underestimation at other watershed in middle reaches. The distribution of annual precipitation over the whole basin is almost reproduced. The estimated decreasing areas of precipitation between the period of 1980-1989 and 1990-1997 also agree well with the dataset.

Keywords: precipitation, watershed, modeling

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JMS009 **Oral Presentation** **949**

Characteristics of the Explosively Developed Cyclone during the winter season of 2005/06

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A large amount of snow was observed in Japan especially along the coastal region facing the Sea of Japan during the winter of 2005/06. Cyclones frequently went through and developed over the eastern offshore of Hokkaido and the Sea of Okhotsk. Rapidly development and stagnancy of cyclones affect the surrounding snowfall distribution and vapor transportation. As the cyclone develops due to the upper level cold vortex advection, it tends to strengthen the cold air outbreak over the Japan Islands and a heavy snowfall may occur along the coastal region facing of the Sea of Japan. In this paper, characteristics of the explosively developed cyclones during the winter season of 2005/06 comparing with 6 winter seasons between 1999/00 and 2004/05. The cyclone's deepening rates were calculated by central sea level pressure deepening between 12 hours normalized to 60N in latitude (Yoshida and Asuma, 2004). The explosive cyclones were defined as the cyclones having their maximum deepening rates exceeded over 1.0 Bergeron among the cyclones which continued over 24 hours. 282 cases were found in total in 7 winter seasons (from December to March) between 1999/00 and 2005/06. Totally 37 explosive cyclones were occurred in 2005/06 winter. The total occurrence number was the almost the same as that of other 6 winter seasons and the deepening rate in 2005/06 winter had a tendency of stronger. And further these tendencies could be found among the 3 explosively deepening cyclone types following to Yoshida and Asuma (2004). Although the cyclones deepening positions were distributed continuously over the north-western Pacific regionin 6 referenced winter seasons (1999/00 - 2004/05), stronger explosively cyclones occurred near the Japan Islands over the Pacific Ocean as well as over the Sea of Japanin 2005/06 winter. Monthly characteristics were also investigatedin the winter of 2005/06. A number of stronger explosively cyclones occurred in December, the explosively cyclones were less in January, stronger but small number of explosive cyclones developed in February and weaker but a large number of explosive cyclones occurred in March. As the explosively cyclones develop by the upper level forcing and lower level moisture supply, these tendencies are reflected by the PV, temperature and moisture advection around Japan Islands.

Keywords: explosively developed cyclone, heavy snowfall

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JMS009 **Oral Presentation** **950**

Cloud-Resolving Model Simulations of Convective Precipitation - Model evaluation in mountainous terrain

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Convective precipitation accounts for most of the summer precipitation, especially in orographically structured terrain, and can lead to significant monetary losses due to hail and/or wind gusts. The need for accurate forecasting of convective precipitation motivated the development of high-resolution numerical weather prediction models. Especially the explicit treatment of deep convection and its associated precipitation is expected to lead to a significantly improved model performance during convective situations. These high-resolution model results allow a process-based evaluation of the model performance also under convective conditions, since most scales of the atmospheric flow are explicitly resolved.We conducted model simulations using the numerical weather prediction model COSMO (formerly known as the Local Model, LM) with a horizontal grid point distance of approx. 2.8 km and without the parameterization of deep convection. Here, we present model results for 12 July 2006, when local convective cells were initiated in the Black Forest region in South-West Germany that lasted about 2 hours, and produced a significant amount of surface precipitation. Detailed observations of the atmospheric conditions were obtained before, during, and after the convective event within the PRINCE (Prediction, identification, and tracking of convective cells) field experiment. Measurements include launchings of radiosondes from mobile and fixed ground stations, cloud and precipitation radar measurements, and the use of Doppler wind and temperature lidar systems. The model results will be evaluated with the field observations. Special focus will be given to the boundary layer structure, the initiation of convection (including its location) and the formation of precipitation. Using high-frequency model output and trajectory analysis, the formation of precipitation in a single convective cell will be analyzed. These investigations allow a detailed evaluation of the model simulations under convective conditions and improve our understanding of the processes leading to convective precipitation.

Keywords: convection, cloud resolving model

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JMS009 **Oral Presentation** **951**

CCN-effects on the development of a convective storm: 2-moment bulk microphysics parameterization compared to spectral bin modeling

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The aim of the EU-project ANTISTORM (Anthropogenic Aerosols Triggering and Invigorating Severe Storms) is to study the influence of aerosols on the development and to improve forecasting of such storms. Especially for predicting severe storms, 3D-simulations using a large enough model domain and high enough horizontal resolution are necessary while at the same time computing time is limited. Consequently, only bulk schemes for microphysics are feasible. But bulk microphysical models comprise many simplifications, especially when only one moment of the particle size distribution (e.g mass density) is predicted while quite simple assumptions have to be made to derive other moments (e.g number density). However, bulk schemes using more than one moment as a prognostic variable seem to be a good compromise. The question is how good such bulk schemes can reproduce the effect of CCNs on the microphysical processes that occur e.g. in a hail storm. The 2-moment microphysical scheme by Seifert and Beheng (2006) with five microphysical categories (cloud droplets, rain drops, cloud ice, snow, graupel) has been extended by "hail" class. The bulk model has been implemented into the 2D-model HUCM that uses bin-microphysics with 43 bins for each of the 7 microphysical categories (drops, 3 categories of cloud ice, snow, graupel and hail/frozen drops). In this way both models can be run within the same dynamical framework. Simulations for different CCN conditions have been performed and the results of both microphysical schemes compared. Seifert, A. and Beheng, K.D., 2006: Meteorol. Atmos. Phys., 92, 45--66. For information on ANTISTORM see http://antistorm.isac.cnr.it

Keywords: convective storms, bulk bin modelling, ccn effects

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JMS009 **Oral Presentation** **952**

Characterizing weather-scale precipitation statistics with the TRMM multi-satellite precipitation analysis

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The TRMM Multi-satellite Precipitation Analysis (TMPA) provides 0.25x0.25 3-hourly estimates of precipitation in the latitude band 50N-50S in two product sets. First, it is computed 6-9 hours after real time using precipitation estimates from TMI, SSM/I, AMSR-E, AMSU-B, and geosynchronous-orbit IR (geo-IR) data, all intercalibrated to a single TRMM-based standard, the TMI-GPROF product. Second, the TMPA is computed about two weeks after the end of each calendar month using the same satellite data as in the real time, but calibrated to the TRMM Combined Instrument (TCI) product, with input from monthly rain gauge analyses. Respectively, these two versions are referred to as the real-time TMPA-RT (3B42RT) and research Version 6 TMPA (3B42) products. The RT suite also includes a combined microwave product (3B40RT) and a microwave-calibrated geo-IR product (3B41RT). The RT data record is inhomogeneous, since we choose not to reprocess it with each algorithm update, while the research product has been reprocessed, although necessarily with a progressively changing set of input estimates, back to January 1998. The time series of the RT and research products are similar, although the gauge influence in the research product typically reduces both the bias and some of the apparently random scatter that the RT displays. Of course, improvement due to the gauge adjustment only occurs where gauges are present, mostly over land. In both products, as well as other satellite-based precipitation estimates, the validation statistics at full resolution are modest, while time/space averaging tends to reveal progressively more skill at progressively larger scales. Typically skill emerges first for more intense events. Analysis shows that the TMPA succeeds in creating precipitation estimates whose distribution of rainrates replicates the distribution of the original calibrating instrument. The TMPA is seeing use in a number of applications, including flood and landslide diagnoses within the authors group. As part of this work, studies of regional variations in weather-scale precipitation patterns are being produced, with comparison to in situ data as feasible.

Keywords: precipitation, satellite, trmm

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JMS009 **Oral Presentation** **953**

Idealized Numerical Sensitivity Studies on Shallow-Convection-Triggered Storms --- Abandoning the "Warm Bubble"

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The influence of orography and other ambient environmental conditions(profile of temperature, humidity and wind) on thedevelopment, the life cycle and the precipitation efficiency of convectivecells is an actual topic in meteorology as well as in numerical weather prediction.In order to elaborate parameters crucially influencing the characteristics ofconvective cells, high resolution cloud resolving simulations with LM areperformed using the novel two-moment bulk microphysical scheme of Seifert andBeheng (2006). To this end, in the past idealized simulations were performed inwhich single convective systems have been artificially triggered either by theclassical 'warm bubble' approach or by wave flow over idealizedorography. The results often exhibited rather strong maximum updraft speeds(Wmax > 50 m/s) and, in case of environmental conditions favorable formulti-/supercell development, a rather quick lateral spreading of theconvective system over the entire model domain. This was accompagnied inalmost all cases by acomparatively low precipitation efficiency, both for maritimeand continentalaerosol conditions. In turn, one possible cause for the low efficiency (aside fromissues reltated to the cloud microphysical scheme) couldbe the vigorous development. The time for a single pass through the updraftregion might be too short for precipitation formation mechanismsknown to be important in midlatitude convective cells to be effective, e.g., riming of supercooled waterby ice particles which then are able to fall out as precipitation. We guess that a part of the reason for this behaviour may be attributed to the fact that thesimulated systems developed isolated and in a rather 'pristine'environment, lacking the interaction with neighbouring convective circulationpatterns.In order to overcome this limitation, the idealized simulations are altered to spin up an ensemble ofinteracting convective circulation systems by explicitly specifying thesurface sensible and optionally the latent heat flux(fixed value or idealized daily cycle), repesentative for a sunny summerday. In this way, the relevant circulation scales (shallow convection) spin up by themselves and, afterCIN has been removed, some deep convective cells develop, which is a wellknown process in the atmosphere. Theresults suggest that a horizontal model resolution of DX <= 200 m might be necessary during spin up ofshallow convection in the boundary layer in order to obtain realistic spacial structureand magnitude of thermal updrafts. However, as the spacial scales grow bigger during development of deepconvection, a coarser resolution of DX = 500 m seems to besufficient to reproduce overall properties of the cloud ensemble fromhigher resolution runs, even though shallow convection is unrealistic.Maximum updraft speeds are lower compared to the formerly performed isolated cell simulationsgiven the same environmental conditions, and vigorous spreading of single systemsis not observed. Therefore, this approach with DX = 500 m isnow used for the sensitivity study mentioned above.Further decreasing the resolution to DX = 1000 m seems to unacceptably degrade theresults.

Keywords: convection, shallow to deep conversion, sensitivities

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JMS009 **Oral Presentation** **954**

The Role of Orography and Soil Moisture in Hydrological Transitions Associated with Monsoon Onset in Southeast Asia

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Floods and droughts caused by Asian monsoons affect agriculture, water resources, and the economies of many Asian countries where billions of people live. The Asian monsoon is composed of three inter-linked components: the South Asian, East Asian, and Southeast Asian monsoons. The appearance of strong convection over the Indochina Peninsula is indicative of the earliest start of the summer monsoon over the Asian continent. The first transitions into the Asian Summer Monsoon (ASM) occur between late April and early May over inland Indochina, before any transitions occur along the coast. The first transition of the ASM is of great importance for agricultural practices and may foreshadow subsequent monsoon evolution. This study used a regional climate model to elucidate the influence of orography and ground wetness on sub-continental-scale hydrological processes. The model reproduced many elements of the onset of the Southeast Asia Monsoon (SEAM) associated with land surface conditions, including the abrupt transitions observed when mountain effects and relatively dry soil conditions were combined in the model simulations. The nonlinear effects of mountains and ground wetness, combined with realistic increases in precipitation, can modify the hydrological cycle through changes in the surface energy budget. A positive feedback between soil moisture and precipitation increases the moisture source for further precipitation in the first transition period.

Keywords: onset, monsoon, rcm

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JMS009 **Oral Presentation** **955**

An Empirical Model for raindrop size distribution in the tropical Indian region

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Raindrop size distribution measurements have been made for varying periods at four different stations in the Southern Indian region using an electromechanical disdrometer. Two stations in the western coast, one in the eastern coast and another in a hill station of 1600m above mean sea level comprise the measurement locations. The data has been used to study the variation of number of raindrops with the drop size. A log-normal distribution fits the data better than gamma or Marshal-Palmer distribution for all the rain rates. The Marshall-Palmer fits well in the lower rain rates. The log-normal distribution expresses the behaviour better than the gamma distribution in the entire rain rate or intensity range. The variation of this log-normal distribution with rain rate or intensity has been studied. Using this, an empirical model for raindrop size distribution as a function of rain rate or intensity has been obtained. The model has been tested with measurements. The details of the model, its validation and limitations will be presented and discussed.

Keywords: dsd, disdrometer, tropics

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JMS009 **Oral Presentation** **956**

Simulation and projection of Arctic freshwater budget components by the IPCC AR4 global climate models

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The state-of-the-art AOGCM simulations has recently been completed for the Intergovernmental Panel on Climate Change (IPCC) in order to provide input to the IPCCs Fourth Assessment Report (AR4). The present paper synthesizes the new simulations of both the 20th- and 21st-century arctic freshwater budget components for use in the IPCC AR4, and attempts to determine whether demonstrable progress has been achieved since the late 1990s. Precipitation and its difference with evapotranspiration are addressed over the Arctic Ocean and its terrestrial watersheds, including the basins of the four major rivers draining into the Arctic Ocean the Ob, the Yenisey, the Lena, and the Mackenzie. Compared to the previous (IPCC Third Assessment Report, TAR) generation of AOGCMs, there are some indications that the models as a class have improved in simulations of the arctic precipitation. In spite of observational uncertainties, the models still appear to oversimulate area-averaged precipitation over the major river basins. The model-mean precipitation biases in the Arcticand sub-Arctic have retained their major geographical patterns, which are at least partly attributable to the insufficiently resolved local orography, as well as to biases in large scale atmospheric circulation and sea-ice distribution. The river discharge into the Arctic Oceanis also slightly oversimulated. The simulated annual cycle of precipitation over the Arctic Ocean is in qualitative agreement between the models as well as with observational and reanalysis data. This is also generally the case for the seasonality of precipitation over the Arctic Oceans terrestrial watersheds, with a few exceptions. Some agreement is demonstrated by the models in reproducing positive 20th century trends of precipitation in the Arctic, as well as positive area-averaged P-E late-20th century trends over the entire terrestrial watershed of the Arctic Ocean. For the 21st century, three scenarios are considered: A2, A1B, and B1. Precipitation over the Arctic Oceanand its watersheds increases through the 21st century, showing much faster percentage increases than the global mean precipitation. The arctic precipitation changes have a pronounced seasonality, with the strongest relative increase in winter and fall, and the weakest in summer. The river discharge into the Arctic Ocean increases for all scenarios from all major river basins considered, and is generally about twice as large as the increase of freshwater from precipitation over the Arctic Ocean (70-90N) itself. The across-model scatter of the precipitation increase for each scenario is significant, but smaller than the scatter between the climates of the different models in the baseline period.

Keywords: arctic, precipitation, evaporation

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JMS009 **Oral Presentation** **957**

Trend analysis of extreme precipitation indices in the Carpathian Basin

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Decadal trends of several precipitation indices have been analyzed for the Carpathian basin on the basis of the guidelines suggested by the joint WMO-CCI/CLIVAR Working Group on climate change detection. These climate indices have been determined from daily precipitation amounts and they are related mostly to extreme precipitation conditions. The analysis has been accomplished for the 20th century, focusing on the second half of the period. The statistical trend analysis includes the evaluation of extreme precipitation indices, e.g., the number of wet days (using several threshold values defining extremes), the maximum number of consecutive dry days, the highest 1-day precipitation amount, the greatest 5-day rainfall total, the annual fraction due to extreme precipitation events, etc. The results suggest that regional intensity and frequency of extreme precipitation increased in the Carpathian Basin, while the total precipitation decreased in the region and the mean climate became drier.

Keywords: extreme precipitation index, carpathian basin, 20th century

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JMS009 **Oral Presentation** **958**

Extraction of doppler profiles during precipitation using complex wavelets

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Rain attenuation studies especially in tropical countries assume significance due to sparse measurements and variability in rain rates and drop size distributions. Conventional techniques are not very significant in dealing with the attenuation due to melting layer and vertical structure of rainfall. The MST radar located at Gadanki is an excellent state of the art system for atmospheric studies. Earlier studies have demonstrated that VHF radars like MST can also be used for precipitation studies. The VHF Radar operating at 53 MHz with a peak power of 2.5 MW is able to provide details of melting layer and drop fall velocities. However, identification of precipitation echo from the clear echo is quite challenging, as 53 MHz is not attenuated by rain. Nevertheless studies have clearly demonstrated in identifying the two echoes. Present Paper deals with new algorithms based on the wavelet analysis techniques (time series data (I & Q)) to deal with the problem. The technique has been used for SNR improvement, and effective tracing of the Doppler profiles even in low SNR regions. The atrmospheric data has been cleaned by denoising using Complex wavelets. Since the denosing is performed on the time series data information regarding the phase is preserved as well. Two types of denoising schemes are present in the literature. The first scheme uses the denoising function found in the Matlab library. The other denoising scheme works on the decomposition and reconstruction of the signal which is performed manually. In the present work algorithms based on second method has been used for the processing of atmospheric radar signals, for the simple reason that this method offers more flexibility to the user . The proposed algorithm performs adaptive Denoising using Complex wavelets, for spectral cleaning. This algorithm uses time series data in contrast to the existing method which uses spectrum data.The SNR of the atmospheric radar signal can be increased by denoising using appropriate Complex wavelets and decomposition levels. After spectral cleaning, the genuine Clear air echoes and Precipitation echoes are selected for drawing Doppler profiles using adaptive window method and maximum slope detection method.

Keywords: precipitation, denoising, complex wavelets

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JMS009 **Oral Presentation** **959**

Recent perspectives in measuring and estimating precipitation: ground and space points of view

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Precipitation is one of the geophysical parameters with higher variability in space and time at all scales, and it is a key factor in many aspects of the Earth system dynamics and a very important leg of the hydrological cycle. Research on precipitation at the ground has been recently influenced by the awareness that it is maintaining the imprint of generating mechanisms in the cloud. So advances are made on the line of measuring instruments (rain-gauges and disdrometers, the latter based on different physical principles) and on the line of polarimetric radar measurements of rain. Using networks of instruments, by means of interpolation techniques continuous precipitation maps are so constructed with rather good spatial and temporal resolution. Due to limitations of previous instruments and methods also satellite images are use to produce precipitation estimates. The present work also discusses the outline of a super-site involving the synergy among a 35 GHz cloud radar, a C-band polarimetric radar and three rain-gage disdrometers of recent development named Pludix (an X band, Doppler Continuous Wave Radar). It is evidenced the importance of the ground radars, able to investigate cloud structure and dynamics, and assessing relevant microphysical properties. The importance of a network of disdrometers to infer the size distribution of liquid and solid precipitation particles and for the calibration of the radar data is also assessed. A discussion of the importance of establishing a proper validation procedure, which is a critical step when developing any rainfall estimation technique is given. Finally it will be shown that synergies among different sensors is now seen as the key to major improvement in precipitation estimation.

Keywords: precipitation, estimation

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JMS009 **Oral Presentation** **960**

Understanding groundwater resources potential of Komadugu Yobe Basin in Nigeira

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Komadugu Yobe Basin (KYB) is a sub-catchment of the larger Lake Chad Basin. The basin is situated in the Sudan-Sahel zone of north eastern Nigeria and south eastern Niger covering an area of 148,000 km2, out of which 84,138 km2 is in Nigeria. The basin is drained by two main river sub-systems: the Yobe River (which is formed by the Hadejia and Jama'are tributaries creating the Hadejia-Nguru floodplain at their juncture) and the Komadugu Gana (or Missau River). The Nigerian sector of KYB accounts for 95% of the basin's total water contribution to the lake. The geological formation of the upstream part of the basin consists of mainly impermeable basement complex rocks which dip away to the east where it is covered with permeable sands, gravels and clays of the Chad Formation. Alluvial sediments are present overlying the Chad Formation close to the rivers. Much of the basin is relatively flat with the only significant hills (the Jos Plateau) rising in the south-west from where the headwaters of the Jama'are River and to a lesser extent the Kano River begin. The majority of the basin falls within Sudan Savannah Ecological Zone which has a natural vegetation cover dominated by shrubs and dense grasses with a minor tree component. Although a substantial portion of available surface water resources of the basin has been developed, the water demand of the basin could not be satisfied. Consequently, there has been an increase in the number of hand-dug wells and boreholes in the basin within the last decade. Available daily rainfall records, temperature, relative humidity and river gauging records in the basin as well as were collated for purpose of assessing the groundwater recharge within the last two decades. A single layer soil water balance technique was adopted for the analysis. The study revealed that while the rate of recharge is decreasing due to declining rainfall, the rate of groundwater exploitation is increasing. The study identified that suitable diameter well could be used to abstract water for small-scale agriculture in some areas of the basin.The study showed that co-ordination of groundwater abstraction in the basin is urgently required, to avoid over-exploitation of the resources in the basin.

Keywords: recharge, estimation, management

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JMS009 **Poster presentation** **961**

Effect of incorporating parameter uncertainty on extreme rainfall estimates.

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Using daily rainfall data taken from fifteen rain gauge stations selected from across South Africa, a Bayesian and an L-moments approach to extreme rainfall frequency estimation were compared. The Bayesian approach enables distribution parameter uncertainties to be taken into account unlike the L moments and other probability weighed moment approaches and the comparison therefore helped evaluate the effect of incorporating parameter uncertainty on extreme rainfall estimates. To implement the Bayesian approach, the Generalized Pareto Distribution (GPD) was used to model the exceedances of rainfall data over a threshold that had been chosen from a mean residual life plot of the rainfall data. The joint prior distribution which had been formulated for the shape and scale parameters of the Generalized Pareto Distribution (GPD) was sequentially modified by the rainfall data resulting in a posterior distribution from which a Markov chain was generated using the Gibbs Sampler. This output of the Gibbs sampler was then used to obtain estimates of rainfall magnitudes at various return periods. These estimates were compared to those obtained using the regional storm index method which uses the Generalized Extreme Value (GEV) distribution and L-moments for parameter estimation. Generally, the Bayesian estimates of rainfall magnitudes for all return periods were greater than the corresponding estimates of rainfall magnitudes obtained by the regional storm index methodology. However, the differences between corresponding estimates increased with the length of the return period and for the shorter return periods, the estimates by the two methods were reasonably similar. At the 100 and the 200-year return periods, the Bayesian estimates were greater by 63.2 % and 87.5 % respectively. These differences in extreme rainfall magnitudes are considered to be the result of incorporating parameter uncertainties in the Bayesian approach. Although flood mitigation design is often wrought with many uncertainties, the considerable impact of incorporating parameter uncertainties calls for a comprehensive review of extreme rainfall estimation methods in South Africa and elsewhere.

Keywords: parameter uncertainty, bayesian inference, generalized pareto distributio

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JMS009 **Poster presentation** **962**

Distributed Rain-on-Snow Mixed Flood Forecast Model and Its Application

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Lilan

Based on summarizing the rule of rainstorm and snowmelt mixed flood, the paper introduces the structure of the distributed rain-on-snow flood forecast model and its application in a mountain watershed of northwest China. The result of simulation and validation indicates that the model has a higher precision of forecasting. Its determinacy coefficient is greater than 0.80. It can be used in the snowmelt flood forecast of watershed. The model is effective approach to advance the precision of runoff forecasting in mountain regions.

Keywords: rain on snow flood, flood forecast, distributed hydrology model

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JMS009 **Poster presentation** **963**

Warm Season Cloud-to-Ground LightningPrecipitation Relationships around Chengdu

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Using 3a observational data from April through October of the XDD03A lightning location system located in Chengdu (104.02E , 30.66N) , this study examines the relationships between cloud-to-ground (CG) lightning and surface precipitation. The region around Chengdu studied is a rectangular-shaped area within 28N-32N, 101E-106E. First, the climatology of CG lightning around Chengdu is studied. It is found that the majority of CG lightning flashes there are positive flashes, the mean intensity of which is 6045A, slightly higher than that of the negative flashes. The intensity of CG flashes is mostly below 12000A. The daily variation of the CG lightning flashes is unimodal undulance, with the peak over 60 at 18:00-21:00 and 01:00 and the valley below 10 at 10:00-13:00. Lightning flashes at night are more than flashes at daytime. The tendency of the daily variation of the positive CG lightning flashes is similar to that of total CG lightning flashes. So is that of the negative CG lightning flashes except some slight fluctuations. The tendency of the monthly variation of the number of the positive CG lightning flashes is similar to that of the negative CG lightning flashes. More flashes occur in June, July and August, while fewer flashes occur in April, May, September and October. It shows that the lightning density there is very dense and the lightning density in June, July, and August is much higher than that in April, May, September, and October. Then the CG lightningprecipitation relationships are evaluated. When comparing monthly gauge-average total rainfall (R(unit: mm)) to corresponding monthly average flash rate (F), a good linear correlation between monthly rain volume and corresponding monthly total CG flashes is found, i.e. R=0.00184F+76.31465, r=0.83488.

Keywords: lightning, cloud to ground, precipitation

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JMS009 **Poster presentation** **964**

A Composite Study of the Heavy Rainfall Events over Northern Taiwan during the Meiyu Season

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Extremely heavy rainfall occurs occasionally during the early-summer rainy season in subtropical China and Japan. This season is called the Meiyu season in China and the Baiu in Japan. The Meiyu season in Taiwan is usually during the period of May and June. The most significant weather system in the Meiyu season is the Meiyu front. Unlike the fronts associated with midlatitude cyclones observed in higher latitudes, they only move southeastward slowly during the early stage of their lifetimes and appear as a quasi-stationary front at the later stage. In the Taiwan area, heavy rainfall events occurring during the Meiyu season are attributed to many large-scale and meso-to-synoptic scale meteorological features. The object of this study is to investigate the roles of different scales of atmospheric circulation in the heavy rainfall events occurring over northern Taiwan by applying techniques of composite analysis and scale separation of meteorological observations. Daily accumulated precipitation data and East Asian weather maps of 12hr interval are the basis for selecting heavy rainfall events. The selected cases are further classified by differences in weather features in addition to Meiyu front. NCEP (National Center for Environmental Prediction) reanalysis data are utilized in the composite analysis and scale separation of meteorological features. In this presentation, kinematic and thermodynamic characteristics of large-scale and synoptic scale circulations for each category of heavy rainfall events will be discussed.

Keywords: meiyu

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JMS009 **Poster presentation** **965**

Lake evaporation of a semiarid small dam using a floating climatologic station data

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The understanding of the effects of the evaporation in the amount and quality of the available water in reservoirs is important ally for the preservation of the sources of supply in the semi-arid, through the efficient management of their waters. To have an estimate of the evaporation in the lake more precise it was used data of a floating climatologic station in an experimental basin of semiarid, located in Serra Negra do Norte, Rio Grande do Norte State, Brazil. This work presents the results of the first year of analysis.

Keywords: evaporation, semiarid, dam

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JMS009 **Poster presentation** **966**

Numerical study of warm detailed microphysics evolution in the centre of cumulus cloud updrafts

Mr. Vitalii Shpyg

Pirnach Ganna

3-D nowcasting model and 1-D forecasting model with detailed description of cloud droplet evolution were used for investigation of interaction between dynamics and microphysics in warm frontal clouds at severe weather events connected with heavy rainfall. Kinetic equation for a drop size distribution function was used for calculation of evolution processes of condensation (evaporation), coagulation, sedimentation of liquid drop. Impact on the formation and development of warm cloud of initial size distribution of cloud droplets was investigated at different dynamic conditions. Cb clouds that have place near Prague in August 12 2002 were selected as object for discussion. At this time over this area passed cyclone that accompanied thunderstorms and rainfall. The diagnostic model developed in UHRI lets to reproduce synoptic situation over target area and to initialize further calculation of warm microphysical characteristics in centre of convective cells caused rainfall. Rawinsond data of 27 stations during 10-12 h GMT over Europe were used for construction of diagnostic models. The nested grid was used for modeling of convective cell replaced near Prague in west side. There were observed the strong updrafts and heavy precipitation. Evident, this cell made a valuable contribution to catastrophic flooded target region in August 2002. Diagnostic thermodynamic data were used in numerical experiments for calculation of evolution of water content, drop concentration, radii of drops and precipitation. Series of numerical experiments were performed for investigation influence of initial distribution of droplets on evolution of the thermodynamic and microphysic features.

Keywords: precipitation, thermodynamics, microphysics

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JMS009 **Poster presentation** **967**

Structure of tropical squall line observed in HARIMAU 2006 campaign

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On 19 November 2006 in the observational period of HARIMAU (Hydro meteorological ARray for Isv-Monsoon AUtomonitoring), the squall line with a length of 150 km and a width of 50 km developed rapidly in the western Sumatra Island, Indonesia. The extensive damage resulting from the windstorm more than 15 m s-1 occurred during the passage of the squall line. The purpose of this study is to describe the detail structure of the tropical squall line using the comprehensive observations and numerical simulation. The passage of the squall line was accompanied by rapid changes in surface temperature, which fell 4C about half an hour with the windstorm. The intense rainfall as much as 5 mm in 10 minutes occurred almost simultaneously with the windstorm, followed by an hour of weak rainfall. We analyzed the vertical structure of the squall line using the volume scan data derived by the two X-band Doppler radars. The strong convective-scale updrafts were observed at the leading edge of the squall line with the maximum more than 5 m s-1 at 3-km level. The strong updrafts raised the warm boundary layer air, forming the intense convective rainfall of squall line. The stratiform rainfall extended 50 km behind the leading squall line, accompanied by the intrusion of rear-to-front flow. Connected with the subsidence of rear-to-front flow, the strong downdrafts developed behind the leading updraft. The mesoscale model MM5 with a horizontal resolution of 3 km successfully reproduced the major features of the tropical squall line, and thus permitted us to investigate the formation mechanism of the strong downdrafts connected with the rear-to-front flow below the stratiform cloud. The inflow of a dry air mass from the middle troposphere by the rear-to-front flow occurred just below the trailed stratiform cloud. Dry air entering just below the stratiform cloud was cooled by evaporation and sublimation, causing it negative buoyancy, hence producing downdrafts. Thus, the formation of a downdraft resulted from the cooling of evaporation and sublimation related to dry air masses carried by the rear-to-front flow toward the moist squall line region. In this case, the mid-troposphere easterlies corresponding to rear inflows were extremely strong, which was identifiable in sounding. It is suggested that the environmental flow in which the squall line occurs determines the intensity of the rear inflow into the squall line.

Keywords: squall line, harimau, mcs

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JMS009 **Poster presentation** **968**

Ecohydrological modeling in the management of water resources

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Badaluta-Minda Codruta, Cretu Gheorghe

In this paper is presented the ecohydrology, as scientifical background to use ecosystem properties, focused on the connections between the aquatic ecosystems and the hydrological cycle. The main purpose of the paper, based on the fundamental concept which says that the water availability is tightly related with the processes which occurs in ecosystems, is represented by the study of the hydrological regime of surface waters, depending on the processes from aquatic ecosystems at the catchment area scale. Are formulated and developed models for the integrative study hydrology-ecology, the steps for the study, starting from a data base, hydraulic, hydrologic, and biological models. In the end are presented the possibilities to integrate the ecohydrological models into the water resources management plan.

Keywords: ecohydrology, modeling, ecosystems

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JMS009 **Poster presentation** **969**

Ecohydrological forecast in assessing the environmental vulnerability

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The vulnerability in ecohydrology is a result of significant extreme hydrological events, induced by human or nature. These events are usually stochastical, if its taken into account their occurrence in time and space, and their monitoring is possible on a data base on long time. In the last time, due to the global warming, these events are more frequent, and the models of forecast need other approaches. In the paper are presented the steps and the scheme of a ecohydrological methodology of forecast. Are developed methodologies into a holistic approach, in such a manner that using ecological parameters to be controlled the hydrological ones from qualitative and quantitative point of view. Each ecosystem has the own capacity to absorb the environment variability (the rainfall and the flow can be intercepted and retained by the vegetation at the soil surface). It is studied the potential to absorb of ecosystems.

Keywords: ecohydrology, vulnerability, methodology

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JMS009 **Poster presentation** **970**

Analysis of time serial of precipitation water vapor sensed by GPS network in three gorges area

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The Three Gorges Region is located in the upstream of the Yangtze River at the boundary of Sichuan and Hubei . The Three Gorges Reservoirs (TGRs) location is in the transfer between the southern temperate zone and the subtropical zone, where it is hot and it rains a lot with the annual rainfall of about 1100 mm. Precipitation makes such an important role for the hydrological environment. As a key factor for precipitation, water vapor changes need to be detected, especially during the Three Gorges Project constructing. After the first impoundment of TGR was completed in the first ten days of June 2003, the acreage covered by water increased from 452km2. Because of the increased water cover over land during the initial filling stage, the atmospheric dynamical conditions and water vapor transportations in the local area could be changed. To see if such changes occurred and how much, detailed observations of Precipitable Water Vapor (PWV) from the Crustal Movement Observation Network of China and the Yangtze River Three Gorges GPS (Global Positioning System) Network are analyzed. The PWV data were retrieved from electromagnetic signal phase delays measured by the GPS sites in the two networks.There are three steps in the PWV computations: 1. Surface and radio sonde (RS) data are matched with GPS data in space and in time. 2. In Retrieval of PWV from GPS data, local modifications, which include the localization of the relationship of atmospheric weighted average temperature (Tm) and surface temperature (Ts) ,are considered. 3. The retrieved PWV were compared and found in good agreement with Radiosonde (RS) and rain gauge observations, indicating that the retrieval methods are physically reasonable. Annual, seasonal and daily changes of PWV before and after the initial impoundment of TGR were analyzed respectively. 1.With the monthly max PWV over two sites (BADN and GUFU) by the Yangtze from 2000 to 2004, annual PWV oscillations show that values of the PWV peaks and valleys after the first impoundment (June 03) is 3-5 mm higher than those before and some abnormal oscillations occurred in winter between Jan. and Apr. in 2004. 2. With daily max PWV at 2 target sites and 1 reference site in 2001 and 2003, the seasonal oscillations indicated that the peak value of PWV in 2003 summer is 5 mm more than the reference site outside the TG reservoir region. 3. The 10-day average of the local PWV after the impoundment is 6mm higher than the 10-day average before the impoundment.Further, the day-to-day variations of the local PWV became smaller after the impoundment. Possible causes of these changes and their potential impacts on the local weather and climate will be discussed.

Keywords: precipitation water vapor, gps, three gorge reservoir

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JMS009 **Poster presentation** **971**

Linking Monthly Precipitation and Atlantic Weather Regimes: An Information Theory Approach

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The Euro-Atlantic monthly-scale variability modes (e.g. NAO index) downscale to characteristic precipitation patterns inEurope. For example NAO+(-) lead to an anomalous deficit (excess) of rain in Southern Europe and an excess (deficit) in Northern Europe. Correlation diagnostics are done to enhance those links. However, joint distributions (precipitation - index regimes) may be locally Non-Gaussian leading to the non-optimality of the Pearson correlation to characterize possible non-linear and asymmetric links between those variables. In order to achieve more general correlation measures, we use the framework of Information Theory. The mutual information (MI), in bits, for the pair (precipitation-index regimes) is computed. The MI is decomposed into a positive Gaussian term (MI-G), directly linked to linear correlation and an extra Non-Gaussian positive term (MI-NG), assessing nonlinear correlations giving the dowscaling potential extra skill beyond that supposing joint Gaussianity. Furthermore asymmetric responses of precipitation to weather regimes are diagnosed through asymmetric non-linear correlations in each posive/negative anomalous regime. Interesting statistical robust features are diagnosed by those approaches as for example the non-linear response of Greenland and Mediterranean winter precipitation to the NAO phases.

Keywords: precipitation downscaling, non gaussianity, weather regimes

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JMS009 **Poster presentation** **972**

Timescale-Dependent Characteristics of U.S. Precipitation Anomalies

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In this study, we have analyzed the most dominant modes of the precipitation using monthly, seasonal, and annual mean data from both observations and the NCEP coupled Climate Forecast System. We have focused on the timescale- and season-dependent features and the physical mechanisms of the precipitation variability. Empirical Orthogonal Function analysis and wavelet analysis have indicated that the variability of precipitation of different timescales posses different loadings of spatial patterns. The dominant patterns of different timescales are linked to patterns of sea surface temperature and atmospheric circulation in different ways. Comparison of observations with model results and analysis of the time-lag relationship between precipitation and SST provide useful information to assess the predictability of the precipitation, for the various seasons, by identifying potential predictors for different timescales in different locations.

Keywords: us, precipitation, variability

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JMS009 **Poster presentation** **973**

WRF model simulation of an intense convective system event over South America

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Rosmerir Porfirio Da Rocha, Tercio Ambrizzi, Luiz Augusto Toledo Machado

Convective systems are usually related to heavy rain events that cause social and economical impacts. However, in spite of the advances in numerical modeling, convective system forecasting is still difficult. In some aspects it is because of the complexity of the dynamic and thermodynamic and the multiscalar interaction involved. In this work the effect of different cumulus parameterization schemes, initial conditions and grid size are analyzed in WRF (Weather Research and Forecasting Model) simulations related to a heavy rain event observed in January 2003, 18 th and 19th, during the SALLJEX experiment (South American Low Level Jet Experiment). Satellite images are used to track the system. Radiosonde and rain gage data are used in the final comparisons. Simulated wind fields present good relation to observed ones. The multicelular structure in the observed precipitation seems to be better represented in the results based on Betts-Miller-Janjic cumulus parameterization and refined grid size. Results are also sensitive to initial conditions, some sensitive experiments show that when better data assimilation is used the model significantly improves the simulated precipitation patterns and it is able to maintain the life cycle the system much closer to the observation. The convective system chose to be simulated here has already been discussed by many previous studies, however the detailed simulated precipitation analysis described here has not been done before.

Keywords: convective system, wrf, salljex

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JMS009 **Poster presentation** **974**

Change of precipitable water vapor obtained by means of GPS at Khon Kaen, Thailand

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Southeast Asia is the largest and clearest monsoon region in the world, and it has been thought that the climate change of this region affect global one. It is, therefore, very important to know the mechanism of the meteorological change of this region to study global climate change. We have been performed the GPS observation on the roof of the building of the Department of Agricultural Engineering, Khon Kaen University in the northeastern part of Thailand, in order to investigate the water vapor change in the troposphere since August 2001 We obtained precipitable water vapor (PWV) changes between 2001 and 2004. The results obtained show that PWV values change between about 10mm and 40mm in the early and late stages of the dry season and between about 5mm and 20mm in the middle stage of its season. In the wet season they are between 40mm and 60mm, and we can see the monsoon break in the PWV change at the center of its season. The onset and offset of the monsoon season are usually decided from rainfall data, but there are sometimes large amounts of water vapor in the atmosphere even if it does not rain. We estimated the PWV boundary condition of the onset and offset, and tried to decide them from PWV data obtained.

Keywords: pwv, gps, thailand

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JMS009 **Poster presentation** **975**

River flow trends in La Plata Basin: relationship with ENSO phases

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Vicente Barros, Ricardo Vidal

During the second half of the twentieth century trends were observed in the river flow series of the principal rivers that compose the La Plata Basin, i.e. Paran, Uruguay, Paraguay and Iguaz rivers. The relationship of these trends with the different phases of El Nio-Southern Oscillation (ENSO) is explored.As river flow changes are characterized by linear trends, under certain conditions, the total linear trend is the result of adding the partial linear trends corresponding to each of the ENSO phases, i.e. El Nio, La Nia and Neutral events. When splitting a series in various sub series, the linear trends of these sub series add up to the same value as the linear trend of the entire series if each of the sub series has its elements ordered in time around the same mean value and variance as the complete series. A linear trend is a special case of a linear regression slope when the independent variable is time. These conditions were approximately fulfilled during the period 1960-1999. This property permits to isolate the linear trends of any variable corresponding to each phase, and therefore, helps to highlight or discard any possible relationship between the linear trends of the variables and the ENSO phases.Annual river flow linear trends were calculated applying a linear regression model to 8 gauging stations: Ladario and Asuncin on the Paraguay River, Salto Caixas on the Iguaz River, Jupi, Itaip and Corrientes on the Paran river and Paso de los Libres and Salto Grande on the Uruguay river; regression coefficients were tested for significance through a t-test. There are positive linear trends in all rivers. Corrientes, located in the lower Paran Basin receives the contribution from three of the rivers: Paran, Paraguay and Iguaz rivers, and therefore having the highest discharge values. Senn's slope values indicate an increase of 172 m3/s per year during the last 40 years at Corrientes which is about 40% of the initial value. These annual trends took place predominantly during the neutral phase of the ENSO, except in the Brazilian stations of Jupi and Itaip where the slope values are higher during El Nio events. At Saltos Caixas slope values are quite similar during both the neutral and El Nio phases. Almost everywhere in the region, no trends or very small ones took place during La Nia periods. Hence, in most of the La Plata Basin river flow trends during the extreme phases of the ENSO constitute only a small part of the trends of the last 40 years of the twentieth century. These results are consistent with those found when analyzing rainfall trends during the same period.

Keywords: riverflow, enso, southamerica

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JMS010 **976 - 1005**

Symposium
Tropical Cyclones

Convener : Prof. Peter Baines, Prof. Roger Smith

Tropical cyclones constitute the most powerful and destructive weather phenomena on the planet. As the recent example of Cyclone Katrina demonstrates, we do not yet fully understand the processes that determine the development and movement of tropical cyclones to the extent that their properties can be forecasted with precision over a time scale of several days. The magnitude of these events also calls for more detailed study of their impacts on coastal environments. Papers on the genesis, movement, dynamics and consequences of tropical cyclones are solicited. These may address observations and forecasting, the interaction with the ocean, and their impact on land, particularly with regard to inundation and rainfall

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JMS010 **Oral Presentation** **976**

Long-wave response of the West Florida shelf to the landfall of Hurricane Wilma, October 2005

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Direct observations of the storm surge and the subsequent long-wave response induced by Hurricane Wilmas landfall on the West Coast of Florida on 24 October, 2005, are presented in this study. The data set consists of weeklong time series of storm surge and barometric pressure measured by the USGS Florida Integrated Science Center. The survey area spanned more than 100 km alongshore from the landfall site northward. The USGS data were augmented with NOAA measurements at two locations: a tide gauge station at Naples, FL (within the USGS array); and a CMAN station at Venice, FL (further to the north). Hurricane Wilma was a fast-moving storm; its translation speed was approximately 20-25 kt (10-13 m/s) at the time of its landfall at 1030-1100 UTC on 24 October 2005. The wind started to gain strength at ~900 UTC and remained strong through ~1500. The strongest wind was observed at 1200-1300, just after the landfall. The storm surge prior to 1200 varied between different locations and was significantly stronger in the proximity of the landfall site. In contrast, the subsequent wave pulse (peaking at approximately 1600 and traveling northward) remained remarkably similar between different stations. The height of the wave pulse exceeded 1.5 m in the detided sea level data. However, its magnitude was somewhat obscured in direct surge measurements because the wave pulse propagated during the low tide. The duration of this wave pulse was approximately 6 hrs. The propagation speed of the wave front was ~25 m s-1, while the pulse crest traveled at a lower speed of ~10 m s-1, which indicates the dispersion effects. A relatively low phase speed suggests that the wave energy was trapped nearshore, in the water depth of 10-20 m. At superinertial frequencies, the edge waves represent long wave modes trapped in the coastal region. Thus, it is inferred that the edge wave pulse of larger spatial and temporal scales was generated following Wilmas landfall. An origin of this wave pulse was the southern sector of the hurricane, where the forced storm surge had a greater magnitude both due to the onshore drift and the convergence of alongshore flow. The surge evolved into a freely propagating wave, possibly the Stokes (zero mode) edge wave, as Wilma rapidly moved inland. The arrival of this edge wave pulse at locations northward from the landfall site marked the highest sea level there during the whole Wilma event. The wave pulse observed at 1600 was followed by a train of much weaker oscillations during the next 24 hr. The edge wave pulse was attenuated by a complex topography in the vicinity of Sanibel Island Pine Island in the northern (downstream) part of the study area.

Keywords: landfall, storm surge, edge wave

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JMS010 **Oral Presentation** **977**

A Godunov-Type Finite Volume Scheme for Simulating Hurricanes

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Hurricanes are characterized by extreme gradients of wind velocities and other thermodynamic quantities such as potential temperature. In addition, the interactions between convective clouds (order of 1km) with large scale synoptic flow (order of hundreds of kilometer) makes it a truly multi-scale problem. An accurate numerical simulation of the hurricane, therefore, requires not only a large computational domain to capture the large-scale flow which, steers the hurricane, but also a high mesh resolution to maintain the intensity of the hurricane circulation. Since, the computational constraints prohibit the use of a uniform high spatial resolution that is appropriate to resolve the smallest scale of interest, significant efforts have been made to develop alternative methodologies, such as, moving nests and adaptive unstructured grids. In this study, a Godunov-type finite volume scheme with adaptive mesh refinement is proposed for simulating hurricanes. The Riemann problem for calculating Godunov fluxes is solved using a flux-based wave decomposition. The scheme is fully-conservative and exhibits minimal numerical diffusion and dispersion. These properties makes it well-suited for simulating flows which are characterized by steep gradients, such as tropical cyclones. This paper describes in detail, the design and implementation of the flow solver. The methodology is then validated against benchmark solutions. Comparisons are made with results obtained from the National Center for Atmospheric Research's state-of-the-art Weather Research and Forecast (WRF) model. Computational efficiency achieved by using adaptive mesh refinement is also demonstrated.

Keywords: hurricanes, godunov methods, finite volume

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JMS010 **Oral Presentation** **978**

Winds and Waves in the Troposphere and Lower Stratosphere during the passage of Tropical cyclones

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Tropical cyclones are violent whirls spiraling up from the oceans to greater heights. Several experiments were carried out using the Indian MST radar located at Gadanki (13.5 N, 79.2 E) to study the atmospheric characteristics during the passage of tropical cyclones. Three cases are considered for the present study in 1994, 2001 and 2002, representing overhead passage, nearby passage and faraway passage, respectively. In the case of overhead passage, in 1994, the available data is used for the study. For nearby (2001) and faraway passage (2002) special experiments were carried out using various experiment specifications. Wind and wave characteristics during the intensification and passage of the storms are studied. The major outcome of the study will be presented in detail.

Keywords: tropicalcyclone, mstradar

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JMS010 **Oral Presentation** **979**

Sensitivity analysis of a statistical-dynamic model with the adjoint method

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The present paper is concerned with the sensitivity of the prediction distance of the statistical-dynamic model (SD-90) with respect to initial positions and initial velocities of tropical cyclone(TC) centers and forces by the adjoint method. First, initial positions, initial velocities and whole forces are retrieved through the variational assimilation method for target TCs, and then, the functional derivatives of the prediction distance of SD-90 are calculated with respect to the initial positions, initial velocities and whole forces. It turns out that, for SD-90, the prediction distance depends on initial latitudes and initial velocities of TC centers, and whole forces, but initial longitudes of TC centers, i.e., variation of longitudes of TC centers has no impact on the prediction distance, variation of latitudes of TC centers has slight impact, and variation of initial velocities of TC centers and of whole forces has big impact. Especially, the functional derivatives of the prediction distance of SD-90 with respect to whole forces exhibit periodically distributed characteristics, and tend to zero. The results are maybe useful for improvement of TC track prediction accuracy.

Keywords: sensitivity analysis, adjoint method, tropical cyclone

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JMS010 **Oral Presentation** **980**

Wind Field Decomposition, Adjustment and Retrievals by Using Variational Method

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The present paper is concerned with three problems: Wind Field Decomposition、Adjustment and Retrievals by Using Variational Method. Part1:We are concerned with characteristics of flow structures of Typhoons, and the double variational method is applied. First, the typhoon flow field is decomposed into two parts: the maximum asymmetric vortex and irrotational environmental flow field; and then, the maximum asymmetric vortex is also decomposed into two parts: the maximum symmetric vortex and -gyres. Finally, Typhoon Pearl(2006) is simulated by WRF (Weather Research and Forcasting Model) , and flow fields at various times at 500 hPa are decomposed by the above method. It turns out that the decomposed flow fields are useful for researches on motion and track prediction of typhoons. Part2: Based on the previous method of Sasaki , the generalized variational optimization method is conducted with regularization ideas in inverse problems. The method can deal well with the wind observations that contain high frequency noises. The observations can be variationally optimized and filtered simultaneously. And the effect and validity of the method is checked in a numerical test. Part3: Based on variational adjoint methods, theoretical analyses and numerical experiments are performed for retrievals of two-dimensional winds and related parameters from single-Doppler radar data in polar coordinates. The method uses the reflectivity conservation equation as a control equation and the mass continuity equation as a weak constraint. At the same time, the stable functional of regularization and background field are also introduced in the cost functional. Based on the ideal experiments with artificial data, real two-dimensional wind fields are retrieved with low-altitude data from Nanjing Doppler radar, and results are encouraging and promising.

Keywords: wind field, variational method, retrieval

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JMS010 **Oral Presentation** **981**

Is African Lightning Activity a Precursor of Atlantic Hurricane Activity?

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Recent years have shown the tremendous damage and loss of life that can be caused by Atlantic Basin hurricanes. The majority of these hurricanes start as African Easterly Waves (AEWs) over the African continent. In this paper we provide evidence showing the connection between lightning activity over eastern Africa, and the AEWs that leave the west coast of Africa, some of which develop into hurricanes. We have analyzed the 2005 and 2006 hurricane seasons, one a very active hurricane year (2005), and the other a very quiet year (2006). More than 90% of the tropical storms and hurricanes during these 2 years were preceded by periods of above average thunderstorm activity in eastern Africa. During the 2006 season not only was the mean east African lightning activity 23% lower than during 2005, but there were 44% less intense lightning days in east Africa during 2006. We suggest the possibility that lightning activity in tropical Africa may represent an important precursor of Atlantic hurricane formation.

Keywords: hurricanes, lightning, aews

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JMS010 **Oral Presentation** **982**

Dependence of vortex axisymmetrization on the characteristics of the asymmetry

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This study investigates how initial asymmetries of different characteristics, including their positions, radial and azimuthal profiles, can impact the vortex axisymmetrization process for barotropic vortices. Linear simulations are carried out first for more clear explanation. When an initial disturbance is placed at the radius of the maximum wind (RMW), a weak new asymmetry is generated inside the original asymmetry and it grows in the early stage due to its upshear tilt. Differential basic-state velocity then shifts the phase to a downshear tilt and the asymmetry loses its energy to the basic state. As the imposed asymmetry is placed outward radially, the initial upshear tilt of the asymmetry decreases, yet the efficiency of the differential rotation to shift the phase tilt also decreases with distance. The latter is related to differential radial propagation of the asymmetry in the form of vortex Rossby waves, as discussed by Montgomery and Kallenbach (1997). These two position-dependent mechanisms act against each other and an optimal radius, at which an initial asymmetry goes through the maximum energy exchange during axisymmetrization, can be determined. For the basic state profile examined, the optimal radius is around 1.8 times the RMW. Asymmetries with a narrower radial profile have similar impacts on the asymmetry. Growth of asymmetries with higher azimuthal wave numbers, however, is much weaker than their lower-wavenumber counterparts in the early stage due to a smaller upshear phase tilt with their smaller azimuthal length scales. Nonlinearity reduces the magnitude and multi-channel production of the newly induced inner asymmetry, and also limits the radial propagation of the asymmetry. The further the asymmetry is away from the center, the slower the axisymmetrization is. The basic state has the largest energy gain near where the asymmetry is placed initially. The results suggest that, whether the maximum intensity of a vortex can be intensified through axisymmetrization depends critically on where the asymmetry is imposed.

Keywords: axisymmetrization

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JMS010 **Oral Presentation** **983**

Tropical Cyclone Impact Forecasting and Warnings in Cuba.

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Cuba is a small island country located in the Northwestern Caribbean Sea, in a position just at the very entrance of the Gulf of Mexico, where Tropical Cyclones have a very high occurrence throughout the Hurricane Season, from June to November. The Atlantic basin has been immersed in an era of more frequent and stronger Tropical Cyclones since 1995. In the 12-year period of 1995-2006 Cuba was affected by 14 Tropical Cyclones, of which 11 were hurricanes. Material losses have been large; fatalities, however, were few, the lowest figure for a country in this Hurricane basin. The methods for achieving such an outstanding result by an underdeveloped country such as Cuba are discussed in this presentation, as well as the models presently used at the Cuban National Forecast Centre to forecast impacts of winds, rainfall, storm surge and coastal floodings, such as the MM5v3 mesoscale model Cuban modified version, an statistical-sinoptic model for wind intensity, as well as the Cuban Monsac-3 model for storm surge and the application of MET-OLAS and the SWAN models for the forecast of coastal flooding caused by hurricanes. There are some examples on the operational methodology in use at the Cuban National Forecast Centre, leading to Early Warnings (72-120 hours before any potential hit) and Warnings (up to 72 hours before); also the wordings and ways in which they are issued and disseminated, with the clear objective of not to induce panic, but confidence in the forecast and urging people to take appropriate protective measures.

Keywords: hurricane, forecast, cuba

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JMS010 **Oral Presentation** **984**

Triggering of the Positive Indian Ocean Dipole Events by Severe Cyclones over the Bay of Bengal

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In this paper, we suggest that positive Indian Ocean dipole events could be triggered by the occurrence of severe cyclones over the Bay of Bengal during April/May. All positive Indian Ocean dipole events during 1958-2003 are preceded by at least one such severe cyclone. Severe cyclones over the Bay of Bengal strengthen the meridional pressure gradient across the eastern equatorial Indian Ocean (EEIO) and hence lead to the intensification of the upwelling favorable southeasterlies along the Sumatra coast. Severe cyclones can also lead to a decrease in the integrated water vapor content and suppress convection over the EEIO. We suggest that the suppression of convection over the EEIO in turn, leads to the enhancement of convection over the western equatorial Indian Ocean (WEIO) and hence to the weakening of the westerlies along the central equatorial Indian Ocean (CEIO). This can lead to a positive feedback between suppression of convection over the EEIO and enhancement of the convergence and convection over the WEIO. If this positive feedback continues until the winds over the CEIO become easterlies, the convection over the EEIO remains suppressed for a period much longer than the synoptic scale. The strong upwelling caused by the easterlies along the equator and southeasterlies along the Sumatra coast decreases the sea surface temperature of the eastern equatorial Indian Ocean very rapidly and a positive dipole event gets triggered.

Keywords: indian ocean dipole, severe cyclone, air sea interaction

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JMS010 **Oral Presentation** **985**

Double structure in the typhoon eye

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In the mature stage of typhoons in the western Pacific Ocean, the double structure can be seen some times in the subtropical region. Airborne observations were frequently made in the research of hurricanes in the Gulf of Mexico. The eyewall replacement process are cleard that the wall cloud in the outer eye moves inword, the inner wall cloud weakened and the eye is replacedby the new eye. The tipical double eyey structures were observed by th weather radar in the typhoon 0314 and 0418 in the subtropiucal region in the western Pacific Ocean. In the passing of these typhoons, the two peaks of higi wind are measured at the serface observation. The other elements of pressure, tempeature and humidity shows the some maximumk and minimum values according to the passing of the double structure of these typhoons. The centers of inner and outer eyes were not concentric. The numerical simulation using the mesoscale model can present partly the structure of the double eye.

Keywords: typhoon, double structure

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JMS010 **Oral Presentation** **986**

Effects of aerosols on lightning and intensity of tropical cyclones

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Alexander Khain, Naftali Cohen, Yaron Segal, Barry Lynn, Daniel Rosenfeld

Some observational evidence and numerical estimations to the effect that the lightning in hurricanes approaching or penetrating the land, especially at their periphery, arises under the influence of continental aerosols affecting the microphysics and dynamics of clouds in tropical cyclones (TC). To show that aerosols foster the lightning formation the 1-D cloud parcel model, the 2-D mixed phase cloud model of the Hebrew University and the 3-D WRF model. All these models have spectral (bin) microphysics. It is shown that aerosols increase amount of supercooled water at upper levels, as a result of which graupel, crystals and water can coexist. It is shown that penetration of continental aerosols may decrease the TC intensity. It is hypothesized that the decay of intensity of TC after their landfall is partially related to the convection invigoration at the hurricane periphery caused by the continental aerosol intrusion.

Keywords: cloudaerosolinteraction, lightning, tcintensityandprecipitation

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JMS010 **Oral Presentation** **987**

Prospects and limitations in hurricane modification by cloud seeding

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An experiment to reduce the intensity of hurricanes by seeding their clouds with large concentrations of submicron cloud condensation nuclei was computer-simulated for hurricane Katrina. The seeding is aimed at suppressing the low-level warm rain at the outer cloud bands, thereby releasing more latent heat of freezing in the periphery aloft, resulting in reduced thermal gradients and hurricane intensity. The first sub-experiment involved the shutoff of all warm rain throughout the hurricane circulation due to the seeding. Although this reduced hurricane intensity throughout the 3-day period of simulation, it is unrealistic because in the real world the generation of giant hygroscopic nuclei from the intense sea spray in the region of strong winds will likely overwhelm the suppressive effect of seeding with the sub-micron hygroscopic nuclei. The second seeding sub-experiment is viewed as more realistic because the shutoff of the warm rain is limited to the hurricane periphery where sea spray is not a major factor. The expected weakening of Katrina was obtained in the numerical simulations of this sub-experiment when the hurricane was in its initial stages, but as the hurricane intensified the sea spray raised by the strong winds overwhelmed the effect of the seeding aerosols and restored the warm rain. This reduced the seeding-induced weakening of the hurricane, and there were even indications that the weakening might be reversed. Although the initial model simulations indicate that it might be possible to modify the intensity of hurricanes and potentially even their tracks, a program of more detailed simulations with explicit microphysics is of interest.

Keywords: cloud seeding, cloud aerosol precipitation, katrina

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JMS010 **Oral Presentation** **988**

Using synergy among satellite sensors to study cyclones

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The tropical cyclone 05B in October 1999 was one of the deadliest cyclones in the Bay of Bengal, claimed lives of more than 10000 people, and did extreme damage to the property. A tropical depression became storm on 26th and cyclone on October 27. In the next days it went on strengthening, finally becoming Category 5 cyclone. Here we take a closer look at this cyclone to study cloud structure, rainfall, winds and other parameters derived from space based sensors onboard various satellites. The MVIRI on METEOSAT-5 monitored the development and movement of this cyclone at 30 min temporal resolution. The AVHRR channel three albedo provides information on the size of ice crystals and cloud droplets. The SSTs are studied using both AVHRR and METEOSAT-5. Seawinds on QuikSCAT data is analysed to observe wind strength and direction, while TRMM data product 2B31 is used to analyse vertical structure of rainfall. The features of this cyclone observed by combining data from above mentioned sensors will be discussed in detail.

Keywords: cyclones, satellite, clouds

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JMS010 **Oral Presentation** **989**

Comparing the Rainfall Patterns of Hurricanes Frances (2004) and Jeanne (2004) During Landfall Over Florida

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During the 2004 North Atlantic hurricane season, Hurricanes Frances and Jeanne made landfall over Hutchinson Island, Florida. These hurricanes were of similar intensity with minimum central pressures of 960 and 950 mb respectively, and were of similar size as measured by the average distance to the radius of gale-force winds (268 km). However, the spatial distributions of storm total rainfall amounts were very different. This paper presents the results of spatial analyses conducted to compare the rainfall distributions of these two hurricanes. Radar reflectivity returns were utilized to determine the spatial extent of the rain shield and were entered into a Geographic Information System (GIS) for spatial analysis at the top of each hour. Several metrics were then calculated to facilitate the comparison of the rain shields of these two storms, including total area covered by each reflectivity value in 5 dBZ increments, the compactness, elongation, and orientation of the rain shield, and determination of the portion of the rain shield located over land. As prolonged duration of high rainfall rates produced by convective clouds leads to flash flooding on the ground, convective rain cells were identified within the radar data and their movement was monitored by calculating their distance and bearing relative to the storm center. These characteristics of the rain shield and embedded convective cells were then related to radar-derived rainfall totals and rainfall totals collected by rain gauges. These data were also analyzed within the GIS and reveal that Frances produced rainfall totals in excess of 254 mm across a large area of north Central Florida on the right side of its storm track, while Jeannes highest rainfall total of 254 mm occurred within a small area to the left of the storm track close to the point of landfall. Using GIS and shape metrics to characterize TC rainfall patterns and relating these patterns to changes in the storm structure during and after landfall could help improve future forecasts for rainfall-induced flooding produced by these storms.

Keywords: rainfall, gis, radar

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JMS010 **Oral Presentation** **990**

Impacts of ice phase processes on tropical cyclone development

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We carrid out idealized cloud-resolving simulations to investigate effects of the ice phase processes on the development and structure of a tropical cyclone (TC). A comparison between cold-rain and warm-rain simulations shows that ice phase processes delay TC organization and weaken the area-averaged kinetic energy. These processes also shrink the TC size, for example, the radius of the storm-force wind area (over 25ms-1) in cold rain is two-thirds that in warm rain.The TC changes essentially originate from strong cooling due to melting and sublimation of snow and graupel near the melting layer. The cooling weakens inflows toward the TC center below the melting level and suppresses the inward transport of high absolute angular momentum (AAM). As a result, the AAM of the cold-rain simulation is considerably smaller than that of the warm-rain simulation. Suppression of AAM transport delays TC organization, and reduction of AAM shrinks TC size. In the cold-rain simulation, the terminal velocities of snow and graupel are slower than that of rainwater. The slow terminal velocities enhance diabatic cooling below the melting level, which suppresses AAM transport.

Keywords: momentum, cooling

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JMS010 **Oral Presentation** **991**

Impact of ocean initial conditions on the seasonal forecast of tropical cyclones

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The frequency of tropical cyclones can be reliably predicted by dynamical seasonal forecasting systems. At ECMWF, operational seasonal forecasts are perfomed with a coupled ocean-atmosphere model in ensemble mode. The ocean model is initialized by assimilating subsurface and altimeter data. In this work we explore the role played by the ocean initial conditions on seasonal forecast of tropical cyclones.

Keywords: tropical cyclones, seasonal forecasts, ocean initial conditions

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JMS010 **Oral Presentation** **992**

Sudden onset of eye occurrence in thermally forced axisymmetric vortices

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This paper investigates axisymmetric balanced flow of a stably stratified non-Boussinesq atmosphere on the f-plane. The flow is forced by heating in the vortex center, which is implemented as relaxation towards a specified equilibrium temperature Te. The flow is dissipated through surface friction, and it is assumed to be almost inviscid in the interior. Previous work has shown that essential vortex properties in this system are controlled by the ratio F = alphaT / cD, where alphaT is the rate of thermal relaxation and cD quantifies the strength of surface friction for a given surface wind. There is a smooth transition between hurricane-like vortices (which occur in the limit of large F) and monsoon-like vortices (which occur in the limit of small F). The present contribution focusses on the occurrence, formation and maintenance of an eye, which is defined with reference to the radial profile of the vertical wind. An eye may occurr even though the equilibrium temperature Te does not predispose any such structure. Key parameter for the existence of an eye turns out be F. The transition between 'no-eye' and 'fully-develped eye' is rather sudden, suggesting strongly nonlinear underlying processes. The point of transition is related to vortex properties like the absolute vorticity and its relation to f. Given Te, the mechanism for eye-formation in our numerical spin-up integration is essentially inviscid. On the other hand, the maintenance of an eye in steady state relates to Ekman-pumping, which is a viscous process. Implications for eye formation in tropical cyclones will be discussed.

Keywords: eye occurrence, vortex

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JMS010 **Oral Presentation** **993**

Sensitivity of a Simplified Tropical Cyclone Intensity Model

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The skill of operational tropical cyclone intensity forecasting is considerably less than that for track forecasting. One of the primary factors in tropical cyclone motion is the advection of the storm circulation by the surrounding large-scale flow. Thus, a reasonably accurate track forecast can be obtained from a model that predicts the synoptic scale motions, even if the details of the storm circulation are not adequately represented. In contrast, intensity prediction requires that the synoptic scale and storm scale motions be accurately represented. The interaction with the underlying ocean surface is also an important factor for intensity changes. Because of the complexity of intensity changes, simplified prediction systems have shown skill comparable to or greater than fully three-dimensional coupled ocean-atmosphere models. These simplified systems range from 2-dimensional axisymmetric hurricane models coupled with a slab ocean model (the Coupled Hurricane Intensity Prediction System (CHIPS) developed by K. Emanuel), to a prediction system based purely on empirical relationships between intensity change and atmospheric and oceanic parameters such as vertical wind shear (the Statistical Hurricane Intensity Prediction Scheme (SHIPS) developed by M. DeMaria and J. Kaplan). In this paper, a new simplified intensity prediction system is presented that is more physically based than the SHIPS model, but is still relies on some empirical relationships. The model evolution is determined by a logistic growth equation (LGE), where the intensity (as measured by the maximum surface winds) is relaxed towards the maximum potential intensity (MPI) when atmospheric factors are favorable. The MPI for this system is determined from the theory developed by K. Emanuel, using input from operational sea surface temperature (SST) analyses and atmospheric soundings from the National Centers for Environmental Prediction (NCEP) global forecasting system (GFS). Given the MPI the LGE model has just one free parameter, which is the growth rate. The growth rate is determined by empirical relationships with vertical wind shear and a convective instability index. It is shown that the LGE model can predict intensity changes with comparable skill to the operational SHIPS model. The sensitivity of the LGE model to the thermodynamic environment is determined by comparing results from forecasts with operational SST analyses to those with experimental high resolution SST analyses based upon microwave satellite observations. The ocean impact is also evaluated by inclusion of an SST cooling parameterization, where the cooling depends on the oceanic heat content estimated from satellite altimetry data. The sensitivity of the LGE model to the atmospheric environment is investigated by comparing forecasts with soundings from the GFS model to those with soundings from satellite retrieval techniques. Results show that the response of this simple model to thermodynamic variability is comparable to that due to variations in the environmental vertical shear. Disclaimer: The views, opinions, and findings in this report are those of the authors and should not be construed as an official NOAA and or U.S. Government position, policy, or decision.

Keywords: hurricane, tropical cyclone, satellite data

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JMS010 **Oral Presentation** **994**

Studying Intense Tropical Cyclones Using the World Wide Lightning Location Network

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Numerous previous studies have attempted to use lightning activity as a proxy for thunderstorm convection over land. However, there have been only a few investigations of lightning activity generated by tropical cyclones. This is mainly because tropical cyclones are oceanic storms that occur away from land-based regional lightning networks. In this paper, we use the World Wide LightningLocation Network (WWLLN), the only real-time network that covers the entire globe, and satellite imagery to analyze the change in lightning activity during the evolution of intense tropical cyclones. We present case studies of tropical cyclones in different global regions, such as the western Pacific and the Atlantic basin, to investigate whether lightning activity can be used as a proxy for convection evolution and organization. For each case study, we discuss where the lightning activity occurs, such as in the eyewall and rainband regions, during different stages of storm evolution. These case studies will be compared to the previous of work of Molinari et al., 1999, Monthly Weather Review, 127 (4), 520-534 that suggest that eyewall lightning intensifies during eyewall replacement cycles during Atlantic basin hurricanes. These eyewall cycles are often covered by thick cirrus overcast and thus can typically only be observed using in situ aircraft measurements. Hence, we examine whether lightning detection can be used to remotely identify the eyewall replacement process. Additionally, to investigate how tropical cyclones sometimes intensify or weaken just before making landfall, we study the lightning activity as the storms approach and hit land. From these case studies, we discuss whether monitoring lightning activity during tropical cyclones can lead to better forecasting and nowcasting of storm evolution, especially where aircrafts measurements are not typically feasible.

Keywords: thunderstorms, lightning

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JMS010 **Oral Presentation** **995**

Characteristics of Atlantic hurricanes from time-series observations

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In the last decade there has been a series of active seasons for hurricanes, including that of 2005. The recent increase in hurricane frequency and intensity may be linked to the trend of increasing global temperatures. Several studies have shown that the rise in global temperatures is correlated with upward trends in sea surface temperature (SST). Such trends have been documented in all ocean regions where hurricanes are formed. The skill in forecasting the seasonal or inter-annual activity of Atlantic hurricanes (AH) with dynamical models is limited, due to a rapid decay of predictability in such models. Nevertheless, time series of data accumulated over more than 100 years yield some insight into the general dynamical features of AH systems. In particular, nonlinear time-series analysis is becoming a reliable tool for the study of complex dynamics from measurements. We present the AH characteristics by analyzing the statistics of long-term time series, illustrating the inter-annual and decadal variability. Hurricane trajectory data, peak wind speed and the eye or minimum pressure all display significant variability over the last century. Power spectrum density (PSD) analysis of time series of annual AH numbers shows periods of ~2-3 years and ~ 5 years. These periods are confirmed by PSDs of the annual SST anomaly, between latitudes of 30 S and 30 N, and of the annual CAR Index (the SST anomaly in the Caribbean region). The analysis presented here suggests that part of AH inter-annual variability can be directly linked to SST variations in the same region. The study underlines the potential role of time-series analysis to complement other statistical and dynamic methods used in the description and forecasting of hurricanes.

Keywords: hurricanes, tropical cyclone, sst

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JMS010 **Oral Presentation** **996**

Boundary-layer Wind Structure in Landfalling Tropical Cyclones

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Tropical Cyclones JMS010 IAMAS

Zhe-Min Tan

In tropical cyclone studies the structure of boundary layer wind field in a tropical cyclone and its dynamics are one of the hot topics at present. The structure of a tropical cyclone, especially in its boundary layer, can be modified by the change of underlying surface during the tropical cyclone landfall. Observational studies showed that there were important differences in the distribution of low-level wind field during a tropical cyclone landfall, and that the winds over the land weakened and turned towards the storm center. Numerical simulations also found that the maximum inflow in the tropical cyclone boundary layer occurred near the maximum wind speed radius in the offshore flow, and the maximum tangential component of wind within the maximum wind speed radius over the sea. It was suggested that the asymmetry of the distribution of wind field in the boundary layer was because of surface drag asymmetry due to asymmetries in the surface roughness, but the dynamics of the structure of boundary layer wind field in a tropical cyclone and of its change was not well known yet. A slab boundary layer model of constant depth is used in this study to analyze the steady flow in the tropical cyclone boundary layer at landfall. In the result of this study, wavenumber 1 asymmetry is obtained in both the tangential and radial components of the steady wind in the tropical cyclone boundary layer during landfall. Radial component is smaller in the west of the tropical cyclone and tangential component is greater in the southeast. Greater total wind speed occurs in the southeast and the maximum exceeds the maximum gradient wind speed. And vertical velocity at the top of boundary layer and vorticity are greater in the west. Budgets of radial and tangential velocity are analyzed. And symmetric structure of boundary layer wind field of tropical cyclone above the homogeneous underlying surface is compared to the asymmetric one of landfalling tropical cyclone. The direct cause for producing such an asymmetric structure of boundary layer wind field in the landfalling tropical cyclone is the asymmetric surface friction and the radial advection. Terms of advection, friction, curvature effect and steady gradient wind at the top of boundary layer are important for the balance of the model equations. Different distances of the core of tropical cyclone to the coastline dont strongly affect the pattern of the boundary layer wind field when the tropical cyclone is very near the coastline. But the amount of the extremum of the radial or tangential velocity is changed.

Keywords: boundary layer, wind, tropical cyclone

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JMS010 **Oral Presentation** **997**

Seasonal Simulation and Potential Predictability of Tropical Cyclones using the FSU/COAPS Climate Model

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Tim Larow, Dong-Wook Shin, Young-Kwon Lim

We use the FSU/COAPS climate model to study cyclogenesis, evolution,intra- to interannual variability and potential predictability of tropicalcyclones. The climate model is run at moderately high resolution (T126 orapproximately 1 degree) and with 27 vertical levels. The model generateshurricane-like vortices that bear remarkable resemblance to their real-worldcounterparts: a warm core with cyclonic inflow at lower levels, anticyclonicoutflow aloft, deep central pressures and intense precipitation. The genesislocation and tracks are consistent with climatological observations. While themodel produces fewer very intense storms (Category 4-5 on the Saffir-Simpsonscale) than observed, the total number of storms and interannual variability isvery reasonable when compared to the historical record. In order to examine potential predictability on seasonal timescales, werun an ensemble of 4 6-month simulations for 20 years (1986-2005) usingprescribed weekly sea surface temperatures. The simulation time period coversthe North Atlantic hurricane season from June 1 to November 30. Each ensemblemember was initialized with a different atmospheric initial condition (near June1 of the respective year) from ECMWF analyses. We find that for the AtlanticBasin, the correlation between the simulated and observed number of storms wasapproximately 0.78. The seasonality of the storms was similar to the observed,with most storms occurring in August and September, though not as sharplypeaked. We further found that there can be large sensitivity to cyclogenesisusing different model parameterizations.

Keywords: hurricanes, cyclones, simulation

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JMS010 **Oral Presentation** **998**

An analytical expression for the amplitude of wavenumber-one vertical velocity in the inner-core region of tropical cyclones under the influence of ambient vertical shear

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It is well known that mature tropical cyclones exhibit highly axially symmetric structure in the core. On the other hand, recent observational studies (e.g., Corbosiero and Molinari 2002; Ueno 2005) have shown that convective activities tend to be enhanced on the down-shear to downshear-left side of the storm rather than evenly significant in the eyewall annulus. In the present study an analytical expression for the magnitude of wavenumber-one vertical motion asymmetries in the inner-core region of tropical cyclones under the influence of ambient vertical shear is derived in an attempt to understand the underlying mechanism for the initiation of asymmetric convection by vertical shear. Then the derived analytical formula is verified against some appropriate numerical model results.

Keywords: vertical wind shear, wavenumber one asymmetry, convective asymmetry

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JMS010 **Oral Presentation** **999**

Numerical Simulation of the intensification and movement of tropical cyclones over Bay of Bengal: A case study

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Dodla Venkata Bhaskar Rao

Prediction of the intensification and movement of tropical cyclones is important for the planning of disaster mitigation. Numerical models are used to provide quantitative prediction of both the intensification and movement. The numerical predictions are sensitive to model physics and dynamics, which are related to the horizontal and vertical resolution of the model. The parameterization of the physical processes such as convection, energy transfer in the planetary boundary layer and cloud microphysics are hypothesized based on resolution. In this study a review of the tropical cyclone prediction as sensitive to the physical processes and horizontal resolution is made.A high resolution mesoscale model NCAR MM5 is used to predict the intensity and movement of the Orissa super cyclone, the most intense cyclonic storm experienced over Bay of Bengal, with an estimated minimum central sea level pressure of 912 hPa and associated maximum wind of 140 knots. This storm was first identified as a low-pressure area over southeast Bay of Bengal on 25 October 1999, later intensified as super cyclone at 15 UTC of 28 October. The cyclone had northwest movement with its landfall near Paradip (20.5N, 86E) on the east coast of around 0500 UTC on 29 October. In this present study, a set of experiments were conducted to study the effect of the horizontal resolution. For this purpose NCAR MM5 is designed to have a fixed domain covering Bay of Bengal and neighboring region and with the chosen parameterization schemes of KF2 scheme for convection; MRF scheme for PBL; and Simple Ice scheme for explicit cloud physics processes. Five experiments were performed, with a single domain with varying horizontal resolutions of 90, 60, 30, 20 and 10 km. Two separate experiments were performed with interactive nested two domains of 90 and 30 km resolutions and 3 domains of 90, 30 and 10 km resolutions. All the experiments were performed with the model integrations starting from 00 UTC of 25 October for 120 hours i.e. up to 00 UTC of 30 October 1999. The results from the single domain experiments indicate that the model simulated cyclone has stronger intensification with increasing resolution i.e. resolutions varying from 90 to 10 km. The minimum central surface pressure and maximum surface wind predicted from these experiments vary from 980 hPa and 34 m/sec at the 90 km resolution to 951 hPa and 55m/sec at 10 km resolution. Contrastingly the results from two domains experiment, the predicted minimum CSP (central surface pressure) and maximum surface wind (MSW) are 954 hPa and 55 m/sec, which are stronger than the single domain experiment with 30 km which predicted minimum CSP and MSW as 969 hPa and 44 m/sec. Similarly the predicted cyclone has stronger intensity in the 3-domain experiment as compared to single domain with 10 km resolution.All the single domain experiments show nearly the same track indicating that horizontal resolution may not have any impact on the track prediction. It is noted that the predicted track agrees with the observations up to 48 hours and then deviates northward and eastwards with increased vector error from 48 to 120 hours. In all the single domain experiments the flow from the boundaries seem to influence the region of cyclone track after 48 hours contributing to a turn towards north and eastwards, with increasing vector errors. Contrastingly the prediction of the track improves in the 2-domain and 3-domain experiment provides the best track nearly agreeing with the observations. The time variation of the different terms in the vorticity equation is examined to understand the dynamics of intensification and movement. The analysis at 850 hPa level shows that the intensification of the cyclone is dominated by the relative vorticity component of the stretching term and horizontal advection becomes significant after mature stage. From the estimates at 500 hPa level, the movement of the storm is noted to be due

to the horizontal advection as well as the relative vorticity component of the stretching term. The change of movement towards north and northeast in the single domain experiment seem to be influenced by sudden change of the tilting term to negative values. These observations indicate that the formation of convection, contributing to increased vertical variation of the vertical velocity is a major factor for the intensification of the tropical cyclone where as the horizontal advection becomes significant only after the storm attains its maturity. An analysis of the potential vorticity (PV) at 500 hPa is also made in order to study the relationship of PV anomalies with the movement. It is noted that the PV anomalies are positive (negative) towards the forward (rear) half of the storm, there by indicating that the PV anomaly gradient from negative towards positive clearly agrees with the movement of the storm. This result indicates that the distribution of the PV anomalies can be used as a predictor for the tropical cyclone movement.

Keywords: tropicalcyclones, physicalprocesses, potentialvorticity

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS010 **Oral Presentation** **1000**

The effects of the vertical wind shear on intensity and rainfall structure of strong storm Biliss(2006)

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The relationships between the strength of the environmental vertical wind shear and the storm intensity and rainfall structure are analysed by virtue of the surface rainfall data estimated from TMI orbit data of TRMM, wind speed on 850hpa and 200hpa from NCEP/NCAR, observation precipitation from auto-observing station each 5 minutes intervals over Chinese land and the intensity, positions, moving directions data of storm Biliss from its document. The results show that the relational coefficients between the vertical wind shear and the storm intensity contemporary and after 6h are 0.59145 and 0.57438 respectively with 0.01 faith standard. The average vertical shear value is 10.9 ms-1during Biliss active process , which locates at a little greater standard than the moderate, and then it is responsible for some inhibiting Biliss intensification. The average azimuthally rainfall rate is smaller in eyewall than in outer spiral rainbands and the maximum rainfall rate is further from the center when the storm intensity become stronger. The relationship between the vertical wind shear and the asymmetrical rainfall structure propose that the heavy rainfall lies in downshear left quadrant and downshear of the storm , which is similar to the effects of vertical wind shear on the asymmetrical rainfall structure around the eyewall . The asymmetries of one wave are the strongest at each radial position. Besides, one wave asymmetries are greater for bigger wind shear than the small one.

Keywords: vertical wind shear, tropical storm intensity, rainfall structure

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JMS010 **Oral Presentation** **1001**

Evaluating and Improving Ocean Model Response to Tropical Cyclones for Improving Intensity Forecasts

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To simulate tropical cyclone (TC) intensification, coupled ocean-atmosphere prediction models must realistically reproduce the magnitude and pattern of sea surface temperature (SST) cooling forced by the storms. The potential for the ocean to support TC intensification depends in part on both temperature and thickness of the upper ocean warm layer as represented by ocean heat content (OHC). Large horizontal OHC differences are associated with energetic boundary currents and ocean eddies, requiring these features to be accurately initialized in the ocean model. Realistic ocean model response also requires optimal parameterization of air-sea fluxes during strong winds in the presence of large surface gravity waves, and also requires realistic representation of vertical mixing in the ocean model, the latter being important because shear-driven entrainment of cold water into the ocean mixed layer produces most of the SST cooling. The ocean model response to TC forcing is investigated using the Hybrid Coordinate Ocean Model (HYCOM), which has been selected by the NOAA National Centers for Environmental Prediction in the as the ocean component of the next-generation coupled hurricane prediction model. In addition to improving our physical understanding of the ocean response to TC forcing, results will be used to devise strategies for improving the simulated SST response with the ultimate goal of improving intensity forecasts. Evaluation of ocean model simulations against high-quality satellite and three-dimensional in-situ observations is a critical component of this effort. Realistic simulations of the ocean response to Hurricane Ivan (Sept. 2004) within the Gulf of Mexico and northwest Caribbean Sea, along with idealized simulations of the response of an initially quiescent ocean, are analyzed to (1) evaluate ocean model initialization procedures, (2) understand the impact of ocean currents and eddies on the SST response, and (3) devise strategies to optimize vertical mixing in the model. The Ivan response is evaluated against microwave satellite SST measurements and moored Acoustic Doppler Current Profiler (ADCP) ocean current observations along the continental shelf and slope of the northern Gulf of Mexico at a location directly hit by the storm. The Ivan simulations were initialized by oceanic fields provided by the latest generation of the U. S. Navy ocean nowcast-forecast system and forced by a quasi-realistic representation of the wind structure derived from aircraft and in-situ measurements. The initial ocean fields provided a good representation of the ocean heat content (OHC) distribution associated with the Loop Current, a recently-detached warm eddy, and two adjacent cold eddies. These features had a large impact on the simulated SST cooling pattern; with the largest cooling (> 5C) occurring within the cold eddies, in reasonable agreement with microwave satellite measurements. The simulated current response to Ivan was dominated by vigorous near-inertial currents that contained both barotropic and baroclinic motions, in reasonable qualitative agreement with observations. Simulations performed using three different vertical mixing parameterizations present in HYCOM reveal substantial differences in SST cooling rate (particularly within the cold eddies), the vertical penetration of the currents forced during the storm, and the temporal decay rate of the near-inertial oscillations driven by the storm, results that will guide ocean model improvement.

Keywords: hurricanes, modeling

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JMS010 **Oral Presentation** **1002**

Mesoscale Model Investigation of Ocean-Atmospheric Interactions and Hurricane Predictive Index (HPI) Associated with Hurricane Katrina land fall over Louisiana-Mississippi Gulf Coast

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Tropical cyclone/hurricane disaster is the costliest and deadliest natural hazard in USA continent. The timely prediction of the storms can significantly reduce loss of lives and damage to property. In the present study, the NCAR Weather Research Forecast Model (WRF) is used to study the role of surface fluxes including heat, momentum, and latent heat, which play a dominant role in the formation and Intensity change of hurricane Katrina. Katrina became a category 1 hurricane and made landfall on the Miami-Dade/Broward county line. After crossing South Florida and entering the Gulf of Mexico, Katrina began to strengthen reaching Category 5 on 28th August about 250 miles South- Southeast of the mouth of Mississippi river. Later Katrina turned to the Northwest and the north, making landfall in Plaque mines Parish, Louisiana just South of Buras with 140 mph winds as category 4 hurricane on 29th August. Mesoscale model simulations are used for forecasting and to receive better understanding of the structure and dynamics of hurricane activity. The model is run on a doubly nested domain centered over the central Gulf of Mexico, with grid spacing of 90 km and 30 km. WRF is run for 6 hr periods, from August 28th to August 30th. The model is capable of simulating the surface features associated with hurricane Katrina including strong heat and latent heat fluxes, intensity change and hurricane track. A Hurricane Predictive Index (HPI) has been developed for land falling hurricane forecast of Katrina over the Gulf of Mexico.

Keywords: ocean atmospheric interaction, hurricane intensity change

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JMS010 **Poster presentation** **1003**

The Emergence of Numerical Weather Prediction: Richardson's Dream to the ENIAC Integrations

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With its unmistakable spiral shape and central eye, the tropical cyclone (TC), including hurricanes and typhoons, is the most memorable feature over the ocean, because of its dangerous strong winds and floods that pose threat at landfall and inland. Several international activities have pioneered the development and application of contemporary techniques for the specification of surface winds and ocean response in tropical cyclones. The methods are refined, upgraded, and applied in hindcast studies to develop definitive extreme ocean response criteria for design of offshore and coastal structures. A hallmark of these endeavors is the meticulous efforts directed towards specification of the time and space evolution of sea surface wind field in cyclones utilizing both in-situ and satellite data. Surface observations over the vast waters are extremely sparse, limited to a few island stations and a ship report. Occasionally, reconnaissance aircraft fill some of this void, but this resource is expensive. With the advent of remote sensing, the detection, tracking and observation of the inner-core convective activities of the storm are made possible. On-board the low inclination Tropical Rainfall Measuring mission (TRMM) is a TC package that includes a passive microwave sensor (TMI), a rain radar (PR), Lightening Imaging Sensor (LIIS) and a visible infrared scanner (VIRS). The intent of this article is to demonstrate their contribution in observations of tropical cyclones, impact on numerical weather forecast and the overriding consideration in emergency response and disaster management. Specific validation results from various research agencies are briefly presented here-in.

Keywords: tropical cyclone, rain radar, eye wall

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JMS010 **Poster presentation** **1004**

Assessing severe wind hazard from tropical cyclones

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Nariman Habili

To quantify the tropical cyclone risk to the Australian community, the Risk Research Group at Geoscience Australia is developing a statistical model of tropical cyclone tracks and wind fields as a component of a complete risk assessment model. This 2D statistical model is designed to determine the local, long-term wind hazard over the Australian region arising due to tropical cyclones. In combination with engineering-based vulnerability models and a national building exposure database, the risk model will provide a complete view of the tropical cyclone risk posed to the Australian community. The cyclone hazard model uses a random-walk technique to generate a database of synthetic tropical cyclone events including parameters such as origin, speed and direction of motion, central pressure and size. The characteristics are sampled from distributions based on historical observations of tropical cyclones in the Australian region. The maximum wind speed field associated with each of the synthetic cyclones is determined with parametric, asymmetric wind fields and empirical gust factors. The wind fields of the simulated cyclones are then used to determine a regional return wind speed at the 50-to-1000 year level. When combined with high-resolution digital elevation models, terrain and shielding databases, the simulated local wind fields provide a spatial assessment of the wind hazard due to tropical cyclones. The primary goal of this modelling work is to develop a spatially-enabled assessment of the long term wind hazard posed to the Australian region by tropical cyclones. The 2D model will be combined with high resolution topography and terrain datasets to obtain the local (house-by-house level) wind hazard for exposed regions of Australia. Additional applications of the model include provision of an impact assessment tool for emergency managers. In the event of a devastating cyclone impact, cyclone characteristics (position, speed, intensity, size) can be fed into the model, where it is combined with detailed topographic and terrain data to determine the areas within the impact zone that are likely to have experienced the worst damage. Individual events may be modelled with the resulting wind field used as forcing for inundation models to study storm surge events. The model is being developed with an open-source philosophy, so it can be released to the risk research community and allow users to contribute to ongoing development of the model. This will also encourage use of the model in other regions of the world, improving the understanding of the hazard of tropical cyclones across the globe.

Keywords: risk assessment, hazard, spatial enablement

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JMS010 **Poster presentation** **1005**

Tropical cyclones formed in 30-day simulation by cloud-system-resolving global nonhydrostatic model (NICAM)

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Masaki Satoh, Hiroaki Miura, Hirofumi Tomita, Tomoe Nasuno, Shin-Ichi Iga, Akira Noda

We are developing an icosahedral-grid non-hydrostatic AGCM, which can explicitly represent cumulus or meso-scale convection over the entire globe. We named the model NICAM (Nonhydrostatic ICosahedral Atmospheric Model). On 2005, we have performed a simulations with horizontal grid intervals of 14, 7 and 3.5 km using realistic topography and sea surface temperature in April 2004 (Miura et al., 2007; GRL). It simulated a typhoon that developed over the Northwestern Pacific in the real atmosphere in 2004. The simulation with the horizontal grid intervals of 14 km was run for 30 forecasting days. In this simulation, several tropical cyclones form over tropical oceans. We will describe the global distribution of these cyclones and meso-scale structures. Although the model still has some problems and is under continuous improvement,we can see what dynamics is to be represented by a global high-resolution model. If we have completed other experiments by July 2007, we will also show the results of them.

Keywords: global highresolution model, cyclone genesis

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JMS011 **1006 - 1106**

Symposium
Monsoon Systems

Convener : Prof. Guoxiong Wu

Monsoons are among the most complex of atmospheric weather phenomena, involving processes on a wide range of space and time scales. They contain much of the rainfall of the tropics, and their variability on even the largest scales is notoriously difficult to predict. The energy released in these systems also has impact on weather in mid-latitudes. In recent years, observations from a variety of field studies and satellite data have provided much more information on monsoons, and progress is being made. This symposium invites presentations on all aspects of monsoon dynamics, including observations, modeling and forecasting studies. Studies involving interactions with the ocean, and the effect of processes on a variety of scales on rainfall, are particularly sought

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JMS011 **Oral Presentation** **1006**

A hydrological onset and withdrawal index for the West Africa

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Gaetani Marco, Dalu Giovanni

We have developed a hydrological prognostic index, HOWI, for the onset and the withdrawal of the West African monsoon, WAM, in the Sahel region, based on the moisture transport vertically integrated through the PBL and horizontally averaged over the region with the maximum variability at the onset or at the withdrawal, respectively. We find that the dates of the onset of the monsoon in the Sahel region determined using the HOWI agree with the dates of the transition of the ITCZ from 5N to 10N and with the dates determined using a method based on rainfall. The uncertainty on the onset date determined using HOWI is comparable or better than that found using these other methods, which is within a standard deviation (ca 2 pentads). As an additional bonus, through the HOWI we can determine the date of the withdrawal of the monsoon with an uncertainty comparable or better than that on the date of the onset. In fact, while the onset has active and passive phases in time and it is fragmented in space, the withdrawal is rather rapid and almost uniformly distributed through the entire monsoonal region, therefore the inherent variability of the onset is generally larger than that of the withdrawal. As a consequence, a late onset usually preludes to a shorter monsoonal season with less cumulated rain.

Keywords: west africa monsoon, onset prediction, hydrological index

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JMS011 **Oral Presentation** **1007**

The progress on the study of atmosphere-land interaction over heterogeneous landscape of the Tibetan Plateau

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Massimo Menenti, Zhongbo Su, Hirohiko Ishikawa, R.A. Feddes, Lei Zhong, Maoshan Li, Weiqiang Ma

The Tibetan Plateau is often called the Third Pole of the earth due to its significance parallel with Antarctica and the Arctic. As a unique geological and geographical unit, the Tibetan Plateau dramatically impacts the worlds environment and especially controls climatic and environmental changes in China, Asia or even in the Northern Hemisphere. Due to its heterogeneous topographic characteristics, the plateau surface absorbs a large amount of solar radiation energy, and undergoes dramatic seasonal changes of surface heat and water fluxes. The lack of quantitative understanding of interactions between the land surface and atmosphere makes it difficult to understand the complete energy and water cycles over the Tibetan Plateau and their effects on global climate change with numerical models. The study on the regional distribution of land surface heat fluxes is of paramount importance for the study of interactions between the land surface and atmosphere over heterogeneous landscape of the Tibetan Plateau. How can we determine the regional heat fluxes over heterogeneous landscape of the Tibetan Plateau? One way is to install as many fluxes measurement instruments as possible in the different land surfaces. The Institute of Tibetan Plateau Research (ITP) of the Chinese Academy of Sciences (CAS) is establishing a Tibetan Plateau Monitoring and Research Platform (TP-MORP) for the study of land surface and atmospheric processes on the Tibetan Plateau. At same time the CAMP/Tibet (CEOP (Coordinated Enhanced Observing Period) Asia-Australia Monsoon Project (CAMP) on the Tibetan Plateau, 2001-2010) stations (sites) are also working continually over the Tibetan Plateau area. Firstly, the establishing and monitoring plan of long-term scale (5-10 years) of the TP-MORP and three new comprehensive observation and study stations will be introduced here. Some results on the local land surface fluxes partitioning (diurnal variation, inter-monthly variation, inter-yearly variation and vertical variation etc) over the three new stations and the stations of the CAMP/Tibet will also be presented. Another way is to use satellite remote sensing. In this study, a parameterization method based on Landsat-7 ETM data and field observations has been proposed and tested for deriving regional land surface heat fluxes over heterogeneous landscape of the Tibetan Plateau. It will be seen that the parameterization method and the derived results are reasonable over heterogeneous landscape.

Keywords: tp morp, tibetan plateau, fluxes

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JMS011 **Oral Presentation** **1008**

Tropical and extratropical influences on South America monsoon system variability in climate simulations.

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The South America Monsoon Region that has its main rainy season in austral summer (DJF) undergoes a strong interannual variability. In some years there are floods in several areas of Southeastern Brazil and in others there are droughts during the rainy season. Precipitation anomalies during this season can cause large impact on several sectors as agriculture, water resources, hydroelectric power, construction, tourism, affecting the economy. Besides the ENSO influences on the South America continent, the intraseasonal variability that affects the convection in the South Atlantic Convergence Zone (SACZ) can also change from year to year. Previous work have shown that the SACZ can be affected by the MJO through the tropical belt and also by the PSA teleconnection through the tropical/extratropical interactions. In the present study, the interannual precipitation variability in several areas of the Monsoon region is analyzed considering the influence of the intraseasonal variability, the transient systems and the associated atmospheric circulation. The monsoon onset and duration are investigated in extreme wet and dry years based on several atmosphere variables. Teleconnection features linking anomalies in tropical as well as in extratropical regions are discussed, considering observational and simulated data from CPTEC/COLA AGCM. First it is seen that the model represents the main patterns of interannual and intraseasonal variability over South America. The dipole precipitation pattern that is observed between the SACZ area and the southern region is simulated considering the intraseasonal variability and also the interannual variability. The model also represents links between SACZ and extratropical variability. Atmospheric features are analyzed associated with extreme wet/dry years in the region. Some indices of variability are calculated and related to the South America Monsoon System, to help further monitoring.

Keywords: simulation, sacz, teleconnection

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JMS011 **Oral Presentation** **1009**

Regional Modeling Over Complex Terrains: Hydroclimate Challenges Over South Asia

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Yun Qian

The climate of South Asia is greatly influenced by the monsoon circulation and topographic forcing represented by complex terrain features including the massive Tibetan Plateau, and narrow mountains such as the western Ghats and Arakan Yoma. Observed rainfall and outgoing longwave radiation show that mountains anchor convection, which lead to intense precipitation on the windward side or further upstream. The impacts of the diurnally varying atmospheric heating associated with these convection centers, particulary those related to narrow mountains, are not well understood. To advance our understanding of the regional energy and water cycle in South Asia, the effects of the Tibetan Plateau and mesoscale mountains must be assessed and realistically simulated. Recently, the Penn State/NCAR Mesoscale Model (MM5) has been used to develop a regional analysis of the hydroclimate of South Asia. The model was applied at 50 km horizontal resolution, with data assimilation to constrain the large scale circulation. Temperature and winds from the NCEP/NCAR global reanalysis were spatially interpolated to the MM5 grids and assimilated in the regional simulation using simple nudging. The simulation was performed for 1998 2004. Evaluation and analysis of the simulation will be presented, focusing on the regional hydrological cycle and effects of the complex terrain on the diurnal and seasonal time scale.

Keywords: monsoon, mountains, diurnal rainfall

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JMS011 **Oral Presentation** **1010**

Influence of Indian Ocean Dipole on poleward propagating intraseasonal oscillations

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Our analysis suggest that the Indian Ocean Dipole (IOD) have a dominant influence on monsoon variability in both intraseasonal and synoptic time scales. It is shown that the negative (positive) IOD years are characterized by coherent (incoherent) poleward propagation of precipitation anomalies from 5S to 25N from observations and coupled model outputs. The rationale behind such an anomaly in poleward propagation of BISO in contrasting IOD years are identified based on the theory of northward propagating BISO, which suggests that convective coupling is involved in genesis and propagation of BISO. The IOD initiates significant changes in the atmosphere, which in turn influences the meridional propagation of BISO. This study assumes significance, considering the role of BISO in modulating the seasonal mean summer monsoon rainfall.

Keywords: monsoon, iod, iso

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS011 **Oral Presentation** **1011**

The East Asia Winter Monsoon Activity and Impact in Vietnam

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Vietnam is located in the South East Asia, entirely belonging to the tropical monsoon climate. Monsoon activity has a big impact in Vietnam. During the winter the East Asia monsoon affects the weather in the Northern Vietnam and the Central Vietnam, and during the summer the South West monsoon affects the Southern Vietnam. The cold air surges associated with East Asia winter monsoon bring the most dramatic effects in the Northern and Central Vietnam causing serious changes in temperature, wind direction and speed that lead to significant weather events such as strong wind with gust, heavy rains in large areas, etc. Especially, in the early winter the northerly cold air surges, like gravity - wave propagation in combination with easterly wind and local topography, sometime with tropial cyclone cause torrential rains lasting for several days, sometime exceeding 1000 mm in the Central Vietnam. As a consequence, in this region severe floods, flash floods and inundation occur affecting the life of millions population causing serious damages for human being and properties. Therefore, predicting the cold air surges and associated significant rain events is of great importance for disaster preparedness. In National Center for Hydrometeorological Forecast, Hydrometeorological Service of Vietnam this is done using NWP, statistic methods and precipitation estimation by high resolution satellite images. This paper will present climatology on winter monsoon and some case studies on predicting the cold air surge and associated significant rain event for the Central Vietnam.

Keywords: winter, monsoon, vietnam

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS011 **Oral Presentation** **1012**

The influence of Tropical Indian Ocean SST on the Indian summer monsoon

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The Indian Summer Monsoon (ISM) is one of the main components of the Asian summer monsoon. It is well known that one of the starting mechanisms of a summer monsoon is the thermal contrast between land and ocean and that sea surface temperature (SST) and moisture are crucial factors for its evolution and intensity. The Indian Ocean, therefore, may play a very important role in the generation and evolution of the ISM itself. A coupled general circulation model, implemented with a high resolution atmospheric component, appears to be able to simulate the Indian summer monsoon in a realistic way. In particular, the features of the simulated ISM variability are similar to the observations. In this study, the relationships between ISM and Tropical Indian Ocean (TIO) SST anomalies are investigated, as well as the ability of the coupled model to capture those connections. The recent discovery of the Indian Ocean Dipole Mode (IODM) may suggest new perspectives in the relationship between ISM and TIO SST. A new statistical technique, the "Coupled Manifold", is used to investigate the TIO SST variability and its relation with the Tropical Pacific Ocean (TPO). The analysis shows that the SST variability in the TIO contains a significant portion that is independent from the TPO variability. The same technique is used to estimate the amount of Indian rainfall variability that can be explained by the Tropical Indian Ocean SST. Indian Ocean SST anomalies are separated in a part remotely forced from the Tropical Pacific Ocean variability and a part independent from that. The relationships between the two SSTA components and the Indian monsoon variability are then investigated in detail.

Keywords: indian monsoon, indian ocean variability, coupled model

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JMS011 **Oral Presentation** **1013**

Diurnal convective activity over Tibetan Plateau in the global cloud-resolving model, NICAM

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The Tibetan Plateau (TP) is the largest plateau on the globe, dynamical and thermal roles of which affect global-scale climate system considerably. In particular, TP is directly relevant to the North Asian arid climate and seasonal evolution of the summer monsoon. Diurnal variability of the convective systems over TP will affect the monsoon seasonal change through modifying the radiation balance above TP. In the conventional GCM, however, the convective activity over TP has been very limitedly simulated mainly due to their low horizontal resolutions. This study analyses the preliminary one-month simulation from the 3.5 km resolution global cloud-resolving model (GCRM), NICAM (Nonhydrostatic ICosahedral Atmospheric Model; Tomita et al., 2005). Experiment was carried out during April of 2004. Previously, most studies, which focused on the convective systems over TP, investigated intensively for the pre-monsoon/monsoon season. Recently, satellite observations have shown that the April is one of the pronounced periods of the cloud activity over TP. The NICAM very well simulates the diurnal cycle of convective systems over TP in April. Convective clouds that are corresponding to the detail orographic structures are generated in the afternoon, which is consistent with the GMS observations. Well-developed convective systems tend to be organized over TP in relation to the diurnal cycle as the passage of synoptic disturbances. Monthly mean characteristics in diurnal variation of cloud height and distribution agree well to that analyzed by GMS although cloud top height from NICAM shows slightly higher than that can be estimated by GMS. The cloud systems generated during daytime tends to present until night in the low resolution NICAM. Such bias becomes much improved as the horizontal resolution become higher. These results indicate that the use of cloud resolving model is very beneficial to study convective activities over TP. Additionally, since the TP influences are not limited to the vicinal region, the GCRM will be useful to improve the seasonal variation of the Asian summer monsoon.

Keywords: tibet, cloud resolving model, diurnal cycle

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JMS011 **Oral Presentation** **1014**

Interdecadal Variability of the Early Summer Surface Heat Flux in the Kuroshio Region and Its Impact on the Baiu Frontal Activity

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In the Kuroshio region (KR), the early summer surface heat flux (SHF) exhibits a rapid increase around 1990 taking part in a climate shift, which is rooted in the interdecadal variability of the subtropical ocean gyre in the North Pacific through weak temperature stratification of the Kuroshio. The sea surface temperature (SST) in the KR, which is largely controlled by subsurface ocean circulations, is positively correlated with the local upward SHF. The positive SHF anomalies in the 1990s reinforced the Baiu frontal activity with a large-scale meridional dipole in the atmospheric circulation in the western North Pacific, i.e., the Baiu/Kuroshio Dipole. Thus, the interdecadal variability of the subtropical ocean gyre in the North Pacific has an impact on the atmospheric circulation through coherent SST and SHF variations in early summer in the KR locally.

Keywords: baiu, interdecadal variability, air sea interaction

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Centennial variations of the global monsoon precipitation in the past millennium: Results from ECHO-G model

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Response of the global precipitation to the external and anthropogenic forcing in the last millennium is investigated by analysis of ECHO-G simulation performed at Max-Planck Institute. We found that the global monsoon precipitation was weak during the Little Ice Age (1450-1850) with three weakest period occurring around 1680, 1460, and 1800, which fell in, respectively, the Maunder minimum, Sporer minimum, and Dalton minimum periods. Conversely, strong global monsoon occurred in the Medieval Warm Period (1050-1250). The prominent upward trend in the global monsoon precipitation occurring in the last two centuries and the remarkably strengthening of the global monsoon in the last 30 years of 20th century are both unprecedented. The change in the global monsoon is in tendon with the global mean temperature change. In the pre-industrial period, changes in the total amount of solar radiative forcing reinforce the thermal contrast between the northern and southern Hemisphere, thereby resulting in the sub-millennium changes in the global monsoon. However, the change of global monsoon in the last century has a spatial pattern that differs from that of the medieval warming period, suggesting the different effects on monsoon precipitation of global warming patterns, which are due to the increases of green house gases and the input solar forcing.

Keywords: simulation, precipitation, millennium

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JMS011 **Oral Presentation** **1016**

Tropospheric biennial oscillation of indian summer monsoon independent of El NIno- Southern oscillation

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On interannual time scales Asian summer monsoon exhibits a fairly distinct biennial tendency. Years of heavy rainfall tend to be followed by a years of less rainfall. This biennial component is known as Tropospheric biennial oscillation (TBO) and appears in a wide range of parameters like precipitation, sea surface temperature, surface pressure and wind. According to this definition, TBO years include most of the ENSO onset years and some other years also. It was believed that the TBO is an integral part of ENSO with reduced amplitude. But it is already observed that the TBO cycle exist in the absence of ENSO also. In this paper, we are concentrating on the TBO cycle of normal (non-ENSO) TBO years. The parameters like convection, SST over the Indian Ocean, zonal circulation and local Hadley circulation shows TBO cycle in the absence of ENSO. But the Pacific Ocean SST is not showing the cyclic reversal of SST anomalies in the normal TBO cycle. The continuous southeast movement of anomalies from Asian monsoon to Australian monsoon is absent in the normal TBO years. The lower level convergence and upper level convergence centers are not reversing in the normal TBO years. But the zonal circulation is reversing with the monsoon. The equatorial east-west circulation has uniform anomalies over the entire Indian ocean in the normal years, while eastern and western Indian ocean has opposite anomalies in the presence of ENSO. The result reveals that the Indian ocean SST and local processes has dominant role in the TBO mechanism in normal TBO years. The Indian Ocean Dipole is absent in the normal TBO years. The local Hadley circulation has upward (downward) motion over monsoon area during strong (weak) TBO years, while the equatorial region has opposite sign of anomalies. On the TBO scale local moisture transport, heat flux and heat transport in the Indian Ocean has dominant role making TBO of India summer monsoon.

Keywords: tbo, non enso tbo, monsoon

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JMS011 **Oral Presentation** **1017**

Climate variability and change in the Southwest Pacific region: observations, global and regional climate simulations

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As part of the CLIP (Climate, Livelihood and Production in the Southwest Pacific) project, the impact of climatic variability and changes on the environment and on the society as well as the adaptation and the vulnerability to climatic changes is investigated for the Solomon Islands. In order to learn about impact of climate variability and change on the environment and the society and about adaptation strategies to the weather and climate phenomena that are important for these islands, field-surveys were carried out on three selected islands. These surveys revealed a number of different weather and climate phenomena that affect the livelihood in the Solomon Islands. Extreme weather events such as tropical cyclones and droughts are of major importance because of the destruction by the heavy winds, torrential rainfall and storm surges on one hand and because of the lack of water (on many islands rainfall is the only source of fresh water) on the other. There are also indications that drought conditions both trigger the occurrence of tropical cyclones and follow them. Another important aspect is the rainfall variability at weekly time scales, in particular when it leads to extensive rainfall during the dry season in austral spring. The occurrence and the characteristics of these weather and climate phenomena undergo pronounced variations related to the El Nio/Southern Oscillation phenomenon, the primary driver of climate variability in the entire tropical Pacific region. Therefore, in this study the variability of these weather and climate phenomena as well as their potential future change due to anthropogenic global warming are investigated. This is done by considering observational data (ECMWF re-analyses and GPCP estimates of rainfall) as well as climate simulations with both a global coupled model (ECHAM5/OM-1) and a regional climate model (HIRHAM5), driven by lower as well as lateral boundary conditions from the global climate simulations and possibly from the ECMWF re-analyses. In the regional climate model, the regional aspects of the climate in the Southwest Pacific region are better represented, allowing for a more realistic simulation of small-scale features such as tropical cyclones and rainfall in association with local convective activity. The latter is particularly important for the rainfall variability. The simulations of the future climate are based on the SRES A1B scenario proposed by the IPCC.

Keywords: southwest pacific region, climate variability change, extreme events

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JMS011 **Oral Presentation** **1018**

A Case Study of the Influence of the Western Pacific Subtropical High on the Torrential Rainfall in Beijing Area

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Summer is a pluvial season in Beijing area. There is high correlation between the total amount of precipitation and the number of days when there are heavy rain events during the rainy season. 72 percent of heavy rain events appear in July and August, and 46 percent among them are affected directly by the Western Pacific Subtropical High (WPSH) when it interacts with westerly trough. Furthermore, the precipitation in the Beijing area during summer is related to the strength, the area and the location of the ridge of the WPSH. In order to further reveal the impacts of the WPSH on the moisture transfer and the circulation situation under which heavy rain occurs, based on dynamic and thermodynamic diagnosis, a case study is performed by employing a 6-hourly and 11reanalysis data achieved at standard pressure levels for the period of 18-20 August 2001. Results show that during the heavy rain period in the lower troposphere, abundant water vapor over ocean is transferred towards continent by the easterlies along the south of the WPSH. The water vapor fluxes are then turned northward and converged with northerlies in the Beijing area. A strong energy front is formed between the westerly trough and the WPSH. The thick layer of moist available potential energy is found to the south of the front, which is then transformed to kinetic energy by the strong ascending motion associated with slantwise vorticity development. In the middle troposphere, the vertically differential vorticity advection and the warm advection to the west of the WPSH destroy the quasi-geostrophic balance in the Beijing area and its neighborhood, the secondary circulation is therefore forced both dynamically and thermodynamically in association with baroclinic perturbations, and in the area the vertical ascent is intensified. Torrential rain then occurs along such a strong energy front with strong low-level cyclonic vorticity development and high-level divergence. Furthermore, along the northward transfer of warm and moist current over the western flank of the WPSH, the stronger vertically differential advection of pseudo-equivalent potential temperature results in the development of convective instability, and is in favor of the intensification of rainfall. All these contribute to the occurrence of torrential rain in the Beijing area, and should be taken into consideration for predicting this kind of heavy rain events.

Keywords: subtropical high, torrential rainfall

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JMS011 **Oral Presentation** **1019**

Impact of Tibetan Orography and Heating on the Summer Flow over Asia

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The influence on the summer flow over Asia of both the orographic and thermal forcing of the Tibetan Plateau is investigated using a sequence of idealised experiments with a global primitive equation model. The zonally averaged flow is prescribed and both realistic and idealised orography and heating are used. There is some similarity between the responses to the two forcings when applied separately. The upper tropospheric Tibetan anticyclone is predominantly forced by the heating but also weakly by the orography. Below this, both forcings tend to give air descending in an equatorward anticyclonic circulation down the isentropes to the west and rising in a similar poleward circulation to the east. However the heating-only response has a strong ascending southwesterly flow that is guided around the south and south-east of the orography when it is included. On the northern side, the westerly flow over the orography gives ascent on the upslope and descent on the downslope. It is found that heating over the Plateau leads to a PV minimum and that if it is sufficiently strong the flow is unstable, producing a quasi-biweekly oscillation. During this oscillation the Tibetan anticyclone changes from a single centre over the southwestern side of the Plateau to a split/double structure with centres over China and the Middle East and back again. These characteristics are similar to observed variability in the region. Associated with this quasi-biweekly oscillation are significant variations in the strength of the ascent over the Plateau and the Rossby wave pattern over the North Pacific. The origin of the variability is instability associated with the zonally extended potential vorticity PV minimum on a -surface, as proposed by Hsu and Plumb (2000). This minimum is due to the tendency to reduce the PV above the heating over the Plateau and to advection by the consequent anticyclone of high PV around from the east and low PV to the west. The deep convection to the south and southeast of the Plateau tends to suppress the quasi-biweekly oscillation because the low PV produced above it acts to reduce the meridional PV gradient reversal. The occurrence of the oscillation depends on the relative magnitude of the heating in the two regions.

Keywords: tibetan plateau, summer, circulation

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JMS011 **Oral Presentation** **1020**

A Proposal of AMY/IMY08 Coordination and Cooperation

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The Asian Monsoon Year (AMY) was proposed as an important element in improving observations, analyses and modelling in the monsoon regions jointly with GEWEX and CLIVAR, as well as CliC and SPARC. The time period for the AMY 2008 will be from April 2008 until March 2009 to cover the full annual cycle of boreal summer monsoon. It will link across to and contribute from plans for the Year of Tropical Convection initiative. The idea of extending this effort to the global perspective of an International Monsoon Year (IMY) is being explored. The initiative will bring together the GEWEX and CLIVAR monsoon efforts in the Austral- Asian region. Chinas strong and active monsoon studies supported by the Chinese Academy of Sciences (CAS), and by the Chinese Meteorological Administration (CMA) are associated with both CLIVAR and GEWEX. Chinese contributions to the AMY08 are introduced briefly. Recently the Chinese Ministry of Science and Technology (MOST) has approved several 5-year national programs. The (AIPO) Program (2007-2011) was jointly proposed by CAS, CMA, Chinese National Natural Science Foundation (NSFC) and the Chinese State Oceanographic Administration (SOA) to study the monsoon coupled ocean-atmosphere-land interaction over the Asia, and Indian and Pacific Oceans (AIPO), focusing on the dynamical effects of heating contrast between the Indo-Pacific warm pool and the Asian continent and their impacts on the Short-Term Climate Variation in China. The project will include a special observing period, tentatively planned for 2008 to 2009, that includes measurements of atmosphere and ocean from ships, buoys and moorings over the South China Sea, Eastern equatorial Indian Ocean and western equatorial Pacific Ocean. Several other programs that will be part of AMY/IMY08 include: 1) South China Heavy Rainfall Experiment (SCHeREX), 2) Drought trends in Northern China and human adaptation, 3) Environmental change over the Tibetan Plateau, its response to global change and the adaptation counter measures, and 4) Aerosols over China and their climatic impacts. These Programs are also introduced briefly.

Keywords: proposal, amy08, coordination cooperation

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JMS011 **Oral Presentation** **1021**

The impacts of diabatic heating on the variation of the Asian summer circulation

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The interaction between monsoon precipitation and the short term east-west variation of the subtropical high over the western Pacific at 500 hPa (SHWP) and the interaction between tropical cyclones and the SHWP location have been studied and discussed by many researchers. It has been indicated that the latent heating associated with precipitation is very important to the variation of the SHWP in short term whether in subtropics or in tropic. However, few studies take account of the impacts of the latent heating in both tropical and subtropical areas at the same time. In our study, we investigate the influence of the latent heating forcings existing in tropic and subtropics at the same time and at the same longitude by using an AGCM, i.e. the IAP/LASG SAMIL model. A sequence of idealized condensation heating are introduced in the western Pacific in an aqua-planet to emphasize the impacts of the imposed heating. Results show that, except strengthening the anticyclonic vorticity to the east of the heating at middle and lower levels, the deep condensation heating can induce a southward wind in upper levels (200 hPa or higher) over the eastern part of the forcing. This induced equatorward wind can lead a high PV advection from high latitude. When the high PV moves down the isentropes to the easterlies in the tropic, it will move westward with the easterly jet. Finally, the high PV anomaly roll up back to high latitude. During this process, the high PV anomaly from high levels causes a low geopotential anomaly, which can reach to 500 hPa and influence the variation of the SHWP further as well as the rainfall in East Asia.

Keywords: latent heating, subtropical high, pv anomaly

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JMS011 **Oral Presentation** **1022**

Soil Moisture Monitoring at the Mongol CEOP Reference Site for the Last Five Years

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In order to grasp the real condition of soil moisture in time and space in the Mongolian plateau, a long-term monitoring of soil moisture by ground-based water cycle stations and satellites has been successfully carrying out in the Mongolian plateau as the framework of CEOP (Coordinated Enhanced Observing Period) and earth observation satellite missions (ADEOS II, AQUA, ALOS, SMOS, and GCOM) since 2000. Fundamental meteorological and hydrological elements by four AWS (Automatic Weather Stations) and twelve ASSHs (Automatic Stations of Soil Hydrology) in the CEOP study area (CEOP Mongol Reference Site) of 120 km by 160 km of the flat soil surface covered with pasture and shrubs have been monitoring since August in 2000 and June in 2001, respectively. The monitoring results showed that the area-averaged soil moisture at the 3 cm and 10 cm depths of all available water cycle stations has been slightly decreasing for the last five years with the increase of temperatures of air, soil surface and soil and net radiation of all AWS, but with the decline of area precipitation. Rainfall events more than 5 mm/day were seen only several times in each late spring and summer and the amount of the rainfall events accounted for 60-80% of the annual precipitation. Remarkable spikes of soil moisture were caused by this rainfall events. Although the AMSR-E soil moisture measurement overestimated a little, the distribution of the AMSR-E soil moisture showed the dry condition of the soil surface in the Mongolian plateau as well as the ground-based monitoring results and to be similar to that of precipitation. The AMSR-E observation can be considered to be useful for the soil moisture measurement in a large scale.

Keywords: soil moisture, water cycle, mongolian plateau

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JMS011 **Oral Presentation** **1023**

The good and bad aerosols: interactions during Indian Summer Monsoon

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Aerosols in the atmosphere are present in two broad categories, 1. naturally produced mineral dust, and 2. man made components such as black carbon. Here we will discuss some of the effects primarily due to the former component on Indian summer monsoon rainfall as well as on biogeochemistry of the Arabian Sea. Patra et al. (2005) have studied the overall impacts of aerosols, transported from the northern Africa and Arabian Gulf region, on the 2002 extreme summer monsoon rainfall deficit. They attributed the rainfall deficit to thick absorbing aerosol cloud resulting relatively cooler sea-surface temperature (SST) in the northern Arabian Sea and reduction in cloud droplet growth through microphysical inhibition over the north-western India. We refer to this effect of aerosols as 'unproductive or bad' for the social system, food production and economic sustainability. More recently Patra et al. (2007b) have focused on the possible effects of aerosol-supplied nutrients on the interannual variabilties in surface ocean chlorophyll. They hypothesize that the same aerosol component has to play significant role in terms of micronutrients (e.g., iron) supply for maintaining the high biological activity in the northwestern Arabian Sea during Jun-Jul-Aug period. It is generally believed that the high biological activity in the surface ocean layer can be one of the feasible pathways to draw-down and sequester atmospheric CO2 in deeper ocean (Patra et al., 2007a). The rise in atmospheric CO2 is a cause of concern due to its role in global warming and climate change. This effect of aerosols can be termed as 'productive or good' for the human civilization. Detailed results will be presented in the meeting. References: Patra, P. K., et al., Indian summer monsoon rainfall: Interplay of coupled dynamics, radiation balance and cloud microphysics, Atmos. Chem. Phys., Sref:, 2005. Patra, P. K., et al., Exploring the sensitivity of basin-scale air-sea CO2 fluxes to interannual to decadal variability in atmospheric dust deposition using ocean carbon models and atmospheric CO2 inversions, J. Geophys. Res., doi:2006JG000236, 2007a. Patra, P. K., et al., Atmospheric deposition and surface stratification as controls of contrasting chlorophyll abundance in the North Indian Ocean, J. Geophys. Res., revised, 2007b.

Keywords: indian summer monsoon, aerosols mineral dust, ocean biogeochemistry

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JMS011 **Oral Presentation** **1024**

Regionality in characteristics of intraseasonal variations over the Indochina Peninsula

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In South and Southeast Asia, intraseasonal variations (ISVs) of precipitation and tropospheric circulation are important features during the rainy season, because they play significant role on appearance of wet and dry spells which effect seriously on human society. With the use of daily rain gauge data observed routinely by meteorological agencies in Indochina countries, this study describes climatological characteristics of the ISVs over the Indochina Peninsula. The ISVs having a 30-60-day time scale (30-60DV) and those having a 10-20-day time scale (10-20DV) are studied separately, because they exhibit different synoptic scale features from each other. We reveal that characteristics of these two ISVs are different significantly from place to place in the peninsula. During the rainy season, variance of the 30-60DV is generally larger in coastal regions than over inland regions and has two local maxima; one found in the coastal region of Myanmar (CMY) and the other in the southern Laos and central Vietnam region (SLCV). Wavelet analysis reveals that the 30-60DV in the CMY is highly active throughout the rainy season (from May to October) and exhibits maximum activity in May-June. In addition, its typical time scale shifts from 40 days to 50 days during middle July. Cross-correlation analysis reveals that the 30-60DV signal propagates northward along western coast of the peninsula along with northward propagation of westerly wind anomaly at the 850-hPa level over the Bay of Bengal which is well-known synoptic scale feature of the 30-60DV. On the other hand, the 30-60DV in the SLCV is active only during July-October, and its signal propagates northwestward. Large variance of the 10-20DV is found in the coastal region of northern and central Vietnam (CNCV) and inland regions. In contrast to the 30-60DV, the 10-20DV activity varies significantly over the course of the rainy season. The activity in the inland regions exhibits two temporal maxima found in May and September and one minimum in July. The 10-20DV in the CNCV, on the other hand, is active during the August-November period. The 10-20DV exhibits high spatial coherence over most of the peninsula, and its signal propagates west-northwestward. Cross-correlation analysis with reanalysis data reveals that westward-propagating negative stream function (cyclonic circulation) anomaly in the lower troposphere, which is a well-known synoptic scale feature of the 10-20DV, exists about 10 degrees of longitude west of the rainfall maximum.

Keywords: intraseasonal variation, indochina peninsula, precipitation

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JMS011 **Oral Presentation** **1025**

Variability of the monsoon regime over tropical South America: the present climate and projections for a 2xCO2 scenario.

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Rodrigo Jose Bombardi

This study investigates the temporal variability of the South America monsoon system (SAMS) over tropical South America with focus on the Brazilian savanna. The onset, end, and total precipitation during the summer monsoon are investigated with observations from the Global Precipitation Climatology Project (1979-2004). Likewise, the variability of SAMS characteristics are investigated using the intergovernmental Panel for Climate Change (IPCC) coupled global climate models. The following models are investigated: MIROC3.2-high resolution (Japan), MRI-CGCM2.3.2 (Japan), UKMO-HadCM3 (UK), GFDL-CM2.0 (USA) in the 20th century (1981-2000) and in a scenario with the double present concentration of CO2 (2xCO2). It is shown that the spatial variability of the onsets over tropical South America simulated by the models for the 20th century run corresponds very well with the observations, particularly for MIROC3.2. There is indication of a change in the tails of the seasonal precipitation distributions over the savanna for the scenario with 2xCO2, comparatively to the present climate for most models. This suggests that probability of extremes (both dry and wet) events over that region changes in a scenario with 2xCO2, which indicates the large vulnerability of the region to possible climate changes resulting from increasing greenhouse gases.

Keywords: south america monsoon, extremes, ipcc models

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JMS011 **Oral Presentation** **1026**

East Asian Study of Tropospheric Aerosols: an International Regional Experiment (EAST-AIRE): a Stepstone to Understand ing Aerosol and Monsoon Interaction

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By modulating atmospheric heating profile, surface energy balance and cloud condensation nuclei, aerosol is being increasingly recognized as a major agent affecting the energy and water cycle. The influence is likely to be particularly strong over a large portion of Asia where aerosol loading is exceptionally high. Aerosol has been hypothesized to interact with the Asian monsoon system and play a significant role in observed changes in precipitation, temperature and atmospheric circulation. Testing the hypotheses requires extensive and reliable measurements concerning aerosol properties, radiative fluxes, cloud microphysics, precipitation, and other atmospheric variables. To this end, the East Asian Study of Tropospheric Aerosols: an International Regional Experiment (EAST-AIRE) has been conducted by a team of scientists from China and US since 2004. Two types of ground observation stations have been operated, together with air-borne and ground-based intensive field campaign. Most extensive measurements are made at the baseline station in Xianghe including 1) radiative quantities (direct, diffuse and total SW and LW fluxes); 2) aerosol optical quantities (optical depth, scattering and absorbing coefficients, vertical attenuation profiles), 3) aerosol physical quantities (size distribution, mass and condensation number), 4) aerosol compositions, 5) precursor gases (ozone, NO, NOx, NOy, CO, SO2), 6) cloud properties (cloud fraction and height, optical depth, liquid water path, particle size). An aerosol observation network provides aerosol loading and size information across China. By combining ground-based, airborne and space-borne observations, we are able to gain much further insight into the direct and indirect effects of aerosols in the region. Some major findings will be presented.

Keywords: aerosol, monsoon, east aire

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JMS011 **Oral Presentation** **1027**

Role of NAO and MJO in predicting the dry/wet spells in indian summer monsoon

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The Indian summer monsoon exhibits prominent 30-40 day fluctuations with "active periods of heavy rain interrupted by dry periods i.e. "Breaks". The circulation anomalies associated with active/break monsoon cover the entire Indian Ocean influences remote tropics and North Pacific Ocean. A prolonged dry/wet period will result in severe drought/flooding, which have profound influences on the south Asia water cycle, agriculture and societal activity of over more than one billion people. The atmospheric general circulation models have great difficulty in simulating the Intra-seasonal oscillation (ISO). Therefore, it is necessary to study the empirical relationship between various atmospheric processes, which are responsible for the ISO. In this paper, the analysis of North Atlantic Oscillation Index (NAOI) and Madden Julian Oscillation Index (MJOI) on daily scale is carried out in relation to daily Indian summer monsoon rainfall (June-September). The analysis is carried out for period 1979-2001. Since the potential predictability limit for monsoon break is about 20 days, the 20 days running lag/lead correlation analysis between the NAOI and MJOI is found out for each year. It is observed that 20-day lag relationship between NAO and MJO is inverse and significant (0.1 level) and this relationship remains negative throughout the break monsoon period and in active phase it reverses. This twenty days lag relationship between NAO and MJO is potential predictor for break/ active monsoon condition over Indian region. The analysis is verified for major drought year 2002. Probable physical linkage for using this relationship for predicting the dry/wet spell in monsoons period could be like this, previous studies have established that the active/break monsoon are triggered by organized northward propagation of heavy precipitating or cloud free zones from the equatorial regions towards the continental land mass. This northward propagating mode (NPM) over the Indian monsoon region was weaker (stronger) during drought (flood). It is also known that the MJO interacts with the NPM in the Indian monsoon region; it is plausible that the different phases of NAO modulate the temperature gradients cold/warm in upper troposphere. Hence, it might be responsible for the increase in the period of the NPM. A longer period NPM could possibly lead to longer monsoon break periods causing the major drought condition and vie versa.

Keywords: nao, mjo, monsoon

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JMS011 **Oral Presentation** **1028**

Feedback between soil moisture and precipitation during the early stages of the South American Monsoon

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The present study summarizes the results obtained from the sensitivity experiments exploring the precipitation response to changes in initial soil moisture conditions, performed using ensembles of one-month long simulations with the regional mesoscale Eta model during early stages of the South American Monsoon. Examination of the control simulations shows that they reproduce all major features and magnitudes of the South American circulation and precipitation patterns, particularly those of the monsoon. The sensitivity experiments show that precipitation is more responsive to reductions of soil moisture than to increases, suggesting that although the soil is not too wet, it is sufficiently humid to easily reach levels where soil moisture anomalies stop being effective in altering the evapotranspiration and other surface and boundary layer variables. Two mechanisms by which soil moisture has a positive feedback with precipitation are discussed. First, the reduction of initial soil moisture leads to a smaller latent heat flux and a larger sensible heat flux, and both contribute to a larger Bowen ratio. The smaller evapotranspiration and increased sensible heat flux lead to a drier and warmer boundary layer, which in turn reduces the atmospheric instability. Second, the deeper (and drier) boundary layer is related to a stronger and higher South American Low-level Jet (SALLJ). However, because of the lesser moisture content, the SALLJ carries less moisture to the monsoon region, as evidenced by the reduced moisture fluxes and their convergence. The two mechanisms reduced convective instability and reduced moisture flux convergence act concurrently to diminish the core monsoon precipitation.

Keywords: soil moisture, precipitation, low level jet

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JMS011 **Oral Presentation** **1029**

Impact of COSMIC GPS radio occultation data on analyses and forecasts of water vapor, clouds, and rainfall over tropical oceans

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Accurate meso-scale analysis of water vapor in the troposphere over tropical oceans including monsoon regions remains a challenge due to the lack of reliable observations. The new COSMIC GPS radio occultation data provides an opportunity to improve the analyses of water vapor. The GPS refractivity contains information about water vapor and temperature in the troposphere with high vertical resolution. The data is not contaminated by clouds and precipitation and has good spatial coverage over the tropical oceans. In this study, we examine the NCAR's Weather and Research Forecast (WRF) model 36-km resolution analyses of water vapor using various satellite observations with/without the COSMIC GPS refractivity over tropical oceans including the Equatorial Western Pacific Ocean. The preliminary results show that the COSMIC GPS data significantly reduces the dry bias of the water vapor analysis in the troposphere. In addition, the WRF meso-scale forecasts of convective clouds and rainfall are also significantly improved by the GPS data.

Keywords: gps radio occultation

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JMS011 **Oral Presentation** **1030**

Roles of the seasonal marches of the SST and land-sea thermal contrast in the Asian summer monsoon

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The influences of the SST and land surface temperature on the onset of the Asian summer monsoon are studied by using an atmospheric GCM, Global Spectral Model (GSM) of Japan Meteorological Agency (JMA). After confirming from five-year control run with the climatological SST that the model performs the Asian summer monsoon well, we make the impacts of two kinds of main experiments, i.e. SST fixed run and solar fixed run focusing on the Asian summer monsoon onset. In the SST fixed run, the model is run from April 1st until June 30th under the SST which is fixed at the value of April 1st. To see impacts systematically, an ensemble average over five cases is compared with that of the control run. The fixed SST considerably reduces the Somali jet, the cross equatorial water vapor transport, the northern-hemispheric evaporation, and then suppresses the ITCZ jump from the southern hemisphere to the northern hemisphere. It also reduces the low-level westerlies from Southeast Asia, which brings the monsoon onset. In the solar fixed run, the model is run from April 1st until June 30th under the solar condition which is fixed at that of April 1st. The fixed solar condition reduces the land-sea thermal contrast, suppresses the heat low over the continent and reduces low level westerlies in a geostrophic sense. The above experiments indicate that both land-sea thermal contrast and SST considerably contributes to the onset of the Asian summer monsoon. The land-sea thermal contrast induces low-level wind surrounding the Eurasian continent, and makes a primary contribution to the formation of the Asian monsoon westerlies. The seasonal march of the SST destabilizes the stratification, induces the ITCZ jump from the southern to the northern hemisphere, strengthens the Hadley circulation, and then enhances the monsoon westerlies through effective transport of the absolute angular momentum.

Keywords: monsoon, sst, solar

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Analysis of Intreaseasonal Variation of Intertropical Convergence Zones Using Continous space-time wavelets.

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Intertropical Convergence Zones (ITCZ) over the Indian and West Pacific regions have a distinct mode of poleward propagation with a time period of about 30-50 days. They generate over the equatorial waters (around 5S) and culiminate over the northern region around 25 N (commonly known as the monsoon trough region). We apply two-dimensional continuous Morlet wavelet analysis in the time-latitude domain to study the intraseasonal variation of ITCZ over the Indo-Pacific region. With the help of this analysis we find that we can identify dominant spatial scale of 30 degrees during the June-September season. Associated with this spatial scale are temporal scales of 30-45 days. We also find that while there is very little interannual variation of the dominant spatial scale, associated temporal scales show significant interannual variation. Such dominant spatial scales and temporal scales are neither seen during the non-monsoon periods over the Indian longitudes nor over other longitudes where poleward propagations are not prominent (such as over Central Africa). Over the Indian region it is also seen that the power is assymetric i.e. there is more in the northward propagating modes than in southward propagating ones. Further extension of this analysis to study zonally propagatingconvective systems in the equatorial region such as the MJO and their interannual variability as seen with continous space time wavelets will also be presented.

Keywords: intraseasonal variation, itcz, space time wavelets

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JMS011 **Oral Presentation** **1032**

Dynamics and thermodynamics of monsoon boundary layer

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Studies of Indian summer monsoon and its associated features are important in the arena of diagnostic purposes, predictability, etc. Characteristics of atmospheric boundary layer (ABL) play vital role during southwest monsoon because many atmospheric mechanism are triggered and controlled by the ABL features. In this perception, a study on the characteristics of ABL during different epochs of southwest monsoon, such as onset phase, active phase, weak/break phase is carried out. The analysis of ABL characteristics is made using the radiosonde data at 12 UTC observations made over Trivandrum (southern tip of peninsular India) and Mangalore (west coast station near central peninsular India). Dynamic and thermodynamic features of the active and weak/break epochs are studied using the vertical profiles of the zonal and meridional wind, specific humidity and potential temperature. Conserved variable analysis (CVA) is also carried out to infer the degree of convection during the different epochs of monsoon. The study reveals that zonal wind around 1.5 km height is strong (23 ms-1) during active monsoon situation in both the stations but that during the weak phase is weak (10 ms-1). The wind core height is confined to 1.5 km level during active phase in both the stations but that during the weak phase is widened to a large layer. In other words, during weak core maximum is smaller than active situation and vertical wind shear is small. During active phase the meridional wind is nearly zero in Mangalore but that over Trivandrum is about 7 ms-1, southward. In the weak phase, an additional along shore component is noticed in both the stations due to the formation of an organised convective cloud band in the equatorial Indian Ocean as the part of the next monsoon surge. The magnitude of the alongshore component in Trivandrum is found high (12 ms-1, southward). From the CVA analysis, we found that the level of q reversal (QR) is more in Trivandrum and the profile in which the QR is less while comparing that with non q reversal (NQR). But in the station Mangalore, the height of QR level is found in lower levels in both active and weak/break monsoon phases. It is also noticed while comparing the active and weak over Mangalore, the level of QR is seen higher in the weak/break monsoon phase and might be due to the non presence of deep convection.

Keywords: thermodynamics, monsoondynamics, boundarylayer

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JMS011 **Oral Presentation** **1033**

How robust is the ENSO-monsoon teleconnection?

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Interannual variability of the Indian summer monsoon rainfall and its close relation with El Nino/Southern Oscillation (ENSO) is known (drought conditions over India accompany warm ENSO events and vice versa), but recent observations suggest a weakening of this ENSO-monsoon relationship and a possible link to global warming is suggested. Here we analyze ENSO-monsoon relationship in a 1000-year control simulation of the MRI coupled GCM (MRI-CGCM2.2). An overall correlation between the JJA Nino3.4 SST and the JJA Indian monsoon rainfall is -0.39 with reasonable circulation characteristics associated with model ENSO. Simulated ENSO-monsoon relationship reveals long-term variations from -0.71 to +0.07 in moving 31-year windows. This modulation in the ENSO-monsoon relationship is associated with decadal variability of the climate system. Future changes in the basic state by global warming in the 21st century scenario experiments give us an insight for future regional climate change and its variability.

Keywords: aogcm, enso, enso monsoonrelation

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JMS011 **Oral Presentation** **1034**

The northern Australian rainy season - onset and retreat indices

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An important feature of some tropical climates is the fact that they are often characterized by well defined onset and retreat dates for the rainy season. The northern Australian rainy season is dominated by the summer monsoon but is also affected by other factors including tropical cyclones, Madden-Julian oscillations and sporadic thunderstorm events. Climate change detection studies typically involve analyses of changes in rainfall amounts or extremes, but climate change can also involve changes in the timing of the events which may also have consequences for the natural and man-made environment. Here, we define indices based on daily observations which provide a measure of the onset date, the retreat date and the duration of a rainy season. These indices are relatively simple, robust quantities that can be calculated for any season (including winter rainfall regimes) for any location. Results for selected stations throughout the northern Australian tropics are presented which provide further insights into the nature of increases in rainfall that have occurred over large regions over recent decades. These include time series of the indices which provide a means of quantifying both long-term trends and any relationships with other factors such as the Southern Oscillation.

Keywords: rainy season, onset, index

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JMS011 **Oral Presentation** **1035**

The radiative impact of an aerosol climatology on the LASG atmospheric GCM in Asian monsoon Region

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Results from an improved LASG (State Key Laboratory of Numerical Modeling for Atmospheric and Geophysical Fluid Dynamic) atmospheric general-circulation model SAMIL (Spectral Atmospheric Model of IAP LASG) are presented, in which the sensitivity of the model to the inclusion of a simple aerosol climatology is investigated. Without aerosol, comparisons with ERBE and ISCCP FD measurements indicate that global annual mean short-wave radiation absorbed in atmosphere is less, but incident short-wave at surface and emitted long-wave radiation at the top of atmosphere (TOA) are overestimated under clear-sky conditions. After including a simple aerosol climatology into SAMIL, the biases of radiation above become smaller. In addition, the simulated radiation flux at TOA and surface in DJF are more close to observational data than relevant flux at JJA. Especially for net incident short-wave at TOA and surface in JJA, there exists larger bias. Moreover, there is more reasonable radiation balance at TOA and precipitation flux in DJF. The diagnostic analysis of SAMIL shows that convection scheme, cloud scheme and some regional deficient of aerosol distribution mainly distribute to the bias of radiation flux. With an improved convection scheme, the simulated radiation is more satisfied with observation and also close to the mean results from IPCC AR4.

Keywords: aerosol, general circulationmodelsamil, radiation

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JMS011 **Oral Presentation** **1036**

Change of East Asia monsoon in global warming projection by a global atmospheric model with a 20-km grid size

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A global warming projection experiment was conducted on the Earth Simulator using a very high horizontal resolution atmospheric general circulation model with 20-km grid size (the 20-km model). Such high horizontal resolution in a global climate model is unprecedented for a global warming projection. Experiments using the 20-km model were conducted by adopting the time-slice method, in which future changes in sea surface temperature (SST) were predicted by an atmosphere-ocean general circulation model (AOGCM) called MRI-CGCM2.3. The A1B emission scenario proposed by the Intergovernmental Panel on Climate Change (IPCC) was assumed in the experiment. In summer, the future climate simulation shows that precipitation and its intensity increases over the Yangtze River valley of China, the East China Sea, Western Japan, and the ocean to the south of the Japan archipelago. Conversely, precipitation and its intensity decrease over the Korean peninsula and Northern Japan. The termination of the Baiu season tends to be delayed until August. In winter, the future climate simulation shows a northward shift of the Aleutian Low, which leads to a weakening of the northwesterly cold surge around Japan. This resulted in the decreased precipitation around Japan.

Keywords: east asia, 20 km mesh agcm, global warming projection

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JMS011 **Oral Presentation** **1037**

A multivariate analysis of the summer northern African circulation in the NCEP-NCAR reanalysis.

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We analyze the statistical link between the lower-tropospheric zonal wind and the meridional cells developing over West and North Africa. We use a singular value decomposition technique and we consider the resulting expansion coefficients as a rough indicator of the variability for compositing the large-scale fields, and in turn for identifying remote anomalies statistically linked to the African Monsoon circulation. We focus on different time-windows: intra-seasonal, inter-annual and long term behaviour. We use the NCEP-NCAR reanalysis since 1979 to 2004. We do not identify a unique mode of variability by varying the time-window. The AEJ experiences meridional shift, mostly over the Western African coast, but the corresponding meridional overturning circulation is quite different as we vary the time-scale. Quite different are also the large-scale circulations corresponding to the coefficients of the different SVD modes.

Keywords: wam, svd, reanalysis

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Spatio-temporal distribution of convective cloud classes during Southwest Monsoon over Indian subcontinent

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The convective clouds are responsible for troposphere-stratosphere exchange and also for much of a tropical rainfall. They especially play an important role in the amount of rainfall over Indian subcontinent and therefore indirectly influence the economy of the region as well. We used 20 years of AVHRR data from four NOAA satellites during southwest monsoon in this study. We further partitioned convective clouds into four classes based on cloud top brightness temperatures. Class I represents the very deep overshooting convective clouds. Class II represents deep convective and Class III clouds are shallow convective. The Class IV combines all these classes. We will discuss and address following main issues. 1) Spatial distribution of these cloud classes in the component months of SW monsoon, 2) Relative distribution and variability among these cloud classes, 3) The maximum height these clouds could attain, and 4) Sensitivity of our results to the time of observation (and/or diurnal cycle).

Keywords: monsoon, satellites, clouds

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JMS011 **Oral Presentation** **1039**

Analysing australian-asian monsoon simulations in current and future climates by some IPCC AR4 models

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As part of the activities under an Australia-China climate change bilateral project, this study reports some preliminary analysis of coupled model simulations in Australia-Asian monsoon regions. Firstly, the model skill in simulating observed surface climate in the monsoon region are analysed by comparing global model simulations from the IPCC AR4 data base for the 20th century with observational data. Furthermore, we have analysed vertically integrated atmospheric precipitable water (PW) and wind (U850, V850) daily fields from the model simulations and compared them against results derived ERA-40 reanalysis. The model skills in simulating seasonal variations of monsoon circulation and atmospheric moisture conditions are discussed. Based on a modified approach, to be presented by a separate study, by combining total precipitable water and low-level wind in defining monsoon onset and retreat, the current climate model skills in simulating some detailed monsoon characteristics such as onset/retreat are evaluated. We then further examine how atmospheric moisture condition and monsoon circulation will change under climate change conditions from the model simulations using the SRES A2 scenario. Finally, we also tempt to investigate possible changes in monsoon onset/retreat dates in future climate change scenarios based on the coupled model results we have obtained. Acknowledgement: This study is funded by the Australian Greenhouse Office (AGO).

Keywords: australian asian monsoon, ipcc ar4, model simulations

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JMS011 **Oral Presentation** **1040**

Diagnosing Australia-Asia monsoon activities with large-scale atmospheric moisture and wind fields

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TheAustralia-Asian monsoon is a dominant feature of the climate system in the region and yet it is a challenge for global climate models, often with coarse resolutions, to reproduce some detailed features of the system. A number of approaches have been proposed to define monsoon onset/retreatdates, based on rainfall, wind or both. Recently,a methodusing total precipitable water to define monsoon onset has been proposed by Zeng and Lu (2004),and Tang (2006) has used such a method to study the variations of monsoon edges in the Asian region. Nevertheless, detailed year-to-year comparison of results using this approach against some published monsoon onset dates inthe Australianregion (Drosdowsky, 1996) suggests that including monsoon circulation seasonal variations in such a diagnosis better reflects the nature of the monsoon system which is characterised by significant seasonal wind and rainfall variations. In this study, we have modified the method from Lu and Zeng (2004) by introducinglow-level wind changes in the diagnosis. Monsoon onset and retreat dates are defined when both atmospheric moisture and wind conditions meet prescribed thresholds. We have compared the results derived from ERA-40 reanalysis data to a number of published results in the Australianand Asian monsoon region. Preliminary results suggestthatthe revised method gives satisfactory onset dates and other features, such as the onset pattern in the Asian monsoon region and overtropical Australia. Results further suggest that one can use such large-scale variables to investigate some detailedaspects of monsoon activities from coarse resolution global climate models. As one example, an analysis of model-simulated monsoon onset and its potential changes fromanIPCC AR4 coupled modelwill be presented. A separate study will show such diagnostic results over Australia-Asian region from other IPCC AR4 models. Acknowledgement: This study is part ofthe Australia-China climate change bilateral project conducted between BMRC and China Meteorological Administration and supported by the Australian Greenhouse Office.

Keywords: monsoon, onset, diagnosis

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JMS011 **Oral Presentation** **1041**

Role of Sea Surface Temperature in influencing the intraseasonal variability of the South China Sea summer monsoon

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The objective of this study is to examine, based on the Tropical Rainfall Measuring Mission (TRMM) satellite data and the National Center for Environmental Prediction (NCEP) II reanalysis data, the role of Sea Surface Temperature (SST)in influencing the intraseasonal variability of the South China Sea (SCS) summer monsoon (SM). A possible mechanism of the thermodynamics involved in the enhancement of the northward propagating precipitation anomalies over the SCS is proposed. Composite analysis of the active phase of precipitation during SCS SM shows that increased SST variability over the off-equatorial regions of SCS are significantly influenced by the downward shortwave radiation flux anomalies, with the suppressed surface latent heat flux anomalies supplementing to the SST variability over those regions. Positive surface air temperature anomalies slightly follow the positive SST anomalies and then destabilize the lower atmosphere between 1000hPa and 700hPa. The positive SST anomalies lead the positive precipitation anomalies over the SCS by ~1 week. The new findings here indicate an ocean-to-atmosphere effect over the off-equatorial regions of the SCS, where underlying SST anomalies tend to form a favorable condition for convective activity and sustain enhanced precipitation during the SCS SM.

Keywords: south china sea, summer monsoon, ocean atmosphere interaction

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JMS011 **Oral Presentation** **1042**

Structure and Dynamics of a Summertime Teleconnection Pattern Associated with Anomalous Convective Activity over the Tropical Northwestern Pacific

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Cumulus convective activity over the tropical western North Pacific is known to be correlated with the tropospheric height field over Japan (Nitta 1987). This anomaly pattern, called the Pacific-Japan (PJ) pattern, is one of the dominant teleconnection patterns that can affect East Asian summertime climate. However, structure and dynamics of the PJ pattern have not been studied comprehensively.In contrast to the picture of baroclinic in the tropics and barotropic in midlatitudes as has been widely accepted, our composite analysis shows that vorticity anomalies of the PJ pattern exhibit zonally-elongated cyclonic and anticyclonic anomalies around the enhanced convection center and to its northeast, respectively, in the lower troposphere, with an apparent poleward phase tilt with height. Vorticity budget analysis indicates the dominant role of the vorticity advection by the mean meridional flow and the β effect over the western North Pacific, in the presence of the vertically-sheared mean meridional flow observed within the boundary region between the Asian summer monsoon and the North Pacific subtropical anticyclone. The associated wave-activity flux is equatorward and poleward in the upper and lower troposphere, respectively, indicating that Rossby wave-like poleward energy dispersion occurs mainly through the climatological-mean lower-tropospheric southerlies over the western North Pacific.Energy budget analysis based on the composited anomalies reveals that the PJ pattern gains energy through baroclinic conversion associated with westward-tilted anomalies embedded in the vertically-sheared westerly Asian jet in midlatitudes, as well as through barotropic energy conversion associated with zonally-elongated anomalies embedded in the exits of the monsoon westerlies and the Trades in the lower troposphere. These energy conversions, the sum of which is comparable in magnitude with the energy generation associated with the anomalous convective heating, can replenish the total energy associated with the PJ pattern within a month, though their efficiencies depend on the location of the anomaly pattern. The primary anticyclonic center in the lower-troposphere tends to be geographically fixed around southeastern Japan, despite the convection center is scattered over the tropical northwestern Pacific. These results indicate a possibility that the PJ pattern can be regarded as a preferred mode of variability inherent to the mean field over the summertime western North Pacific, characterized by the Asian jet, Asian monsoon and North Pacific subtropical anticyclone. Indeed, in a steady, linear, two-level quasi-geostrophic model with an idealized basic flow that includes a subtropical jet as well as a pair of a low-level monsoonal cyclone and a subtropical anticyclone, a PJ-like response emerges in response to prescribed heating located between the pair, with energy conversions similar to those obtained for the observed PJ composite. Furthermore, the second least damped singular mode for the same basic field shares the fundamental features of the heat-induced response, justifying the characteristics of the PJ pattern as a dry preferred mode.

Keywords: pj pattern, preferred mode, zonally varying mean field

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JMS011 **Oral Presentation** **1043**

Air-sea interaction of a summertime teleconnection pattern associated with anomalous convective activity over the tropical northwestern Pacific

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Anomalous monsoonal convective activity around the Philippines is known to influence the summertime subtropical anticyclone over the northwestern Pacific in the form of the so-called Pacific-Japan (PJ) teleconnection pattern. The pattern has been regarded as a Rossby wavetrain or one of the barotropically unstable modes of variability embedded in the summertime upper-tropospheric zonally-varying mean flow, which can be excited diabatically by enhanced convection. Our composite analysis has revealed, however, that the monthly PJ pattern can be regarded as a preferred mode of variability that extracts energy via "dry" energy conversions from the three-dimensionally varying mean field over the summertime western North Pacific, characterized by the Asian jet, Asian monsoon and North Pacific subtropical anticyclone. Still, "moist" diabatic energy generation is found comparable in contribution to the energetics to the dry energy conversions. In association with the PJ pattern, the convective activity intensifies where the low-level moisture flux converges climatologically. The associated low-level anomalous circulation strengthens the monsoon westerlies over the South China Sea and the Trades over the subtropical western North Pacific. With evaporation from the ocean surface thus enhanced, moisture convergence into the anomalous convection further intensifies, indicative of positive feedback. A diagnosis using a linearized omega equation reveals that anomalous vorticity and thermal advections associated with the PJ pattern must accompany an anomalous ascent in the region of enhanced convection, contributed mainly by anomalous meridional vorticity advection in the upper troposphere. These processes act to reinforce the enhanced convection, suggestive of a hypothesis that the PJ pattern is a moist preferred mode inherent to the boundary region between a continental summer monsoon to the west and a maritime subtropical anticyclone to the east, characterized by climatologically active monsoonal convection. Our composite analysis reveals that the monthly PJ pattern with enhanced convection tends to accompany positive SST anomalies over the tropical northwestern Pacific in the preceding month, as a precondition favorable for enhanced moisture supply. However, in some cases the formation of the pattern follows negative SST anomalies over that region, consistently with the characteristics of the pattern as a preferred mode. Furthermore, the monthly PJ pattern, which mostly behaves as intraseasonal variations, is significantly correlated with neither the interannual ENSO nor the Indian Ocean dipole, although its lag correlation with ENSO increases on the seasonal timescale.

Keywords: pj pattern, teleconnection, preferred mode

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JMS011 **Oral Presentation** **1044**

An Objective method for assessing regional scale Active and Weak Monsoon situation

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Indian Summer Monsoon is a dominant weather system responsible for more than 71 % rainfall over most parts of . The organized convection associated with the monsoon system is responsible for the heavy precipitation. It is found that the wind core of Low Level Jetstream (LLJ) is directed to the region of the organized convection. As the monsoon season progresses, the organized convection moves to the north. The regional rainfall characteristics of the monsoon system depend on the location of the organized convection. Here, an attempt is made for identifying the monsoon activity over 10 different regions in the Indian Subcontinent based on the OLR and wind. Low values of OLR over a region can be considered as an indicator for organized convection. The analysis was carried using NOAA - OLR and NCEP/NCAR 850 h Pa winds. Organized convection in the selected regions were identified first. Then the location of LLJ wind core in the vicinity of organized convection was identified. By trial and error, most suitable area for the LLJ wind core for the organized convection for this region is found. On the basis of the area averaged wind strength at 850 h Pa, the monsoon activity over the region is identified. Since the organized convection moves as the monsoon surge passes, the monsoon activity also changes its location. When the area averaged wind strength at 850 hPa is greater than a particular value, we can consider that the monsoon is active over the region and when the wind strength is less than a value, the region has weak monsoon situation. The area average of 850 h Pa wind and OLR for various years have been considered for all these regions. The average wind, as well as OLR was plotted for the period from May-1 to October-15 of different years. On analyzing we found that the area average of the 850 h Pa wind magnitude gives an indication of the strength of the monsoon flow of the representing regions and near by areas. The Active-Weak cycles are also studied, and interpreted using the same method. The corresponding variation of averaged wind with monsoon activity could be seen. This will serve as an objective method to determine the monsoon strength in different locations. Further results will be discussed in the paper.

Keywords: monsoon, area averaged wind, outgoing longwave radiation

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JMS011 **Oral Presentation** **1045**

Observational study of low frequency variability of the East Asian Summer Monsoon

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It has been known for a long time that the East Asian summer monsoon (EASM) displays substantial interdecadal variability in the distribution of precipitation across Chinathat has important implications for society. In recent years the question of what climate change may mean for monsoon precipitation has become more pressing and there is a need to understand how the effects of climate change may interact with these decadal shifts in precipitation. Inter-annual to decadal variability of EASM has been investigated using new and more comprehensive instrumental records from China for the period of 1958 to 2002. Large interdecadal variability is apparent. The first two patterns of precipitation highlight regional anomalies in East China: the well documented change in the 1970s with opposite sign in the Yangtze and Yellow River valleys, and the increase in the south of China in the recent 20 years. Low-frequency variability in other observed variables (diurnal temperature range, maximum and minimum temperature, total cloud cover and low-level cloud) have also been analyzed in these regions. In some cases there is a strong relationship with the precipitation change. Unlike previous studies of low frequency variability, the daily data have been used to consider the evolution of the monsoon season. Results show that interdecadal variability is often manifested through changes in the seasonal cycle, particularly for the Yangtze and Yellow River valleys, whereas signals in the south of China reflect an overall weakening (strengthening) during the whole summer. Global warming is evident in the temperatures particularly from 1990s onward in all regions. However the very recent decline in precipitation over southern China suggests that the increase over the previous 20 years may not be a response to global warming but instead indicative of a natural decadal mode.

Keywords: easm, low frequency, intraseasonal evolution

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JMS011 **Oral Presentation** **1046**

Convection over West Africa as a remote response to intraseasonal sea surface temperature anomalies in a GCM

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Convective anomalies over West Africa during the monsoon season are simulated as a response to sea surface temperature (SST) anomalies associated with the Madden-Julian Oscillation (MJO) over the equatorial warm pool region. An atmosphere-only global circulation model is used and forced with SST anomalies based on the dominant mode of convection over the warm pool during the Northern Hemisphere summer. The response is analysed using lagged composites. Positive (negative) SST anomalies have upward (downward) vertical motion and positive (negative) mid-tropospheric temperature anomalies leading to locally enhanced (reduced) convection approximately 3 days later. These mid-tropospheric temperature anomalies propagate eastwards as a Kelvin wave and westwards as a Rossby wave, reaching Africa approximately 10 days later. The positive (negative) temperature anomalies act to stabilise (destabilise) the troposphere resulting in suppressed (enhanced) convection over the Gulf of Guinea, extending over West and Central Africa. Possible mechanisms for the convective responses over Africa are investigated and the orography of a region is also shown to be important in initialising convective anomalies over other regions of the tropics as a response to these SST anomalies.

Keywords: african, monsoon, mjo

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Another Look at Monsoon Annual Variability and Its Application to Evaluate Monsoon Simulation in AMIP Models: Wind Vector Rotational Regimes

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Based on the seasonal reversal of wind vector which is the essential characteristic of monsoon, a new concept, the directed angle, is introduced to study rotational regimes of global wind vector and monsoon annul variability. Compared with the previous studies using angle between wind vectors, this concept better reflects the daily variations of wind direction including the rotational direction and amplitude. According to the concept, six categories of wind vector rotation with seasonal cycle have been detected and classified as follows: (I) Clockwise to counter-clockwise rotation; (II) Counter-clockwise to clockwise rotation; (III) Full clockwise rotation; (IV) Full counter-clockwise rotation; (V) Stable style; (VI) Instable style. In monsoon regions, the wind generally rotates in the forms of the first four categories with seasonal evolution. The global distribution pattern of wind vector rotation regime shows that different rotational styles of wind vector are closely related to seasonal evolution of atmospheric circulation systems, including the strength and movement of trough and ridge, the development, movement and split of anticyclone or cyclone, as well as the seasonal variation of solar radiation. Moreover, different monsoon systems possess different wind vector rotational styles with seasonal evolution, for instance, the South Asian monsoon is the style II while the East Asian monsoon is the style IV, the style I is showed in the South China Sea, and the style III in the South Indo-China Peninsula and the West Africa . In addition, this study employed this new concept to evaluate the model outputs of 8 AGCMs of AMIP in IPCC 4th assessment. The results show that this application not only reflects the dynamic process and global distribution of wind vector rotational styles in monsoon simulation, but also embodies the abilities for AGCMs to reproducing circulation seasonal variations. In general, most models show the global distribution pattern reasonable well compared to the corresponding observations, but so little skill is shown in the monsoon rotational styles of some models, especially in South China Sea and West Africa . Moreover, the simulations differ mostly from observations during the transitional season.

Keywords: monsoon, directedangle, amip

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Active-break cycles of the indian summer monsoon in a coupled GCM: response of the ocean surface fields

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Active-break cycles are an important component of the Indian Summer Monsoon (ISM). Understanding and prediction of active and break phases, therefore, are of fundamental importance for agricultural planning, water management and thus for the economic development of the country. In the present study, the active-break cycle is investigated using a 100-year simulation of the atmosphere-ocean coupled global climate model (HadCM3). The performance of the model in simulating the active-break cycle is compared with a flux-adjusted version of the same model (HadCM3FA) having reduced basic state errors in the Indian Ocean and west Pacific, and also with observed data. The criterion to define the active and break monsoon conditions is based on a composite monsoon active/break structure of outgoing longwave radiation (OLR), which shows a dipole between the Indian subcontinent and east equatorial Indian Ocean.Active-break cycles with characteristic time scales of 10-20 days and 30-60 days are examined by applying a Lanczos filter to the daily anomaly fields. The percentage of variance explained by each band in model OLR are found to be in good agreement with observed OLR. Westward propagation of the 10-20 day mode, and northward and eastward propagation of the 30-60 day mode are examined in HadCM3 and HadCM3FA and compared with observations. It is found that both the temporal and spatial structure of the intraseasonal modes and their link with the northward and eastward movement of convection and the underlying oceanic response are well depicted in HadCM3 and HadCM3FA. The SST over Bay of Bengal cools (warms) after about five days of strong (weak) convection associated with heavy (weak) precipitation, while over the eastern equatorial Indian Ocean the SST cools (warms) after about 12 days of strong (weak) convection and associated heavy (weak) precipitation. In order to understand the complex air-sea interaction associated with the active-break cycle, ocean surface fields such as wind stress, latent and sensible heat fluxes and net shortwave radiation, together with mixed layer depth (MLD), are examined. The spatial and temporal coherence evident in the active-break cycles of OLR, MLD and latent heat flux suggest the important role of ocean-atmosphere coupling in monsoon intraseasonal oscillations and the ability of the model to depict the same. Results from HadCM3 and HadCM3FA are similar, indicating that errors in the basic state have little influence on the simulation of active-break cycles. This is in contrast to previous studies with this model that showed substantial improvements in interannual monsoon-ENSO teleconnections.

Keywords: monsoon, intraseasonal, active break

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The effect of doubled CO2 and model basic state biases on the monsoon-ENSO system

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The impact of doubled CO2 concentration on the Asian summer monsoon is studied using a coupled ocean-atmosphere model. Both the mean seasonal precipitation and its interannual variation are found to increase in the future climate scenario presented. Systematic errors in current climate simulations of the coupled system prevent accurate representation of the monsoon-ENSO teleconnection, of prime importance for seasonal prediction and for determining monsoon interannual variability. By applying seasonally varying heat flux adjustments to the tropical Pacific and Indian Ocean surface in the future climate simulation, some assessment can be made of the impact of systematic model error on future climate scenarios. In simulations where the flux adjustments are implemented, the response to climate change is magnified, with the suggestion that systematic biases may be masking the true impact of increased greenhouse gas forcing. The teleconnection between ENSO and the Asian summer monsoon remains robust in the future climate, although the relationship takes on more of a biennial character in the flux adjusted simulation. Systematic biases have a greater impact on the teleconnection than variations in CO2 forcing. Wide decadal timescale variations in the amplitude of the monsoon-ENSO relationship, despite the absence of external forcing, suggest that recent changes in the observed record may represent internal variation.

Keywords: india, systematic error, el nino

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JMS011 **Oral Presentation** **1050**

Does aerosol weaken or strengthen the South Asian Monsoon?

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Aerosols are known to have the ability to block off solar radiation reaching the earth surface, causing it to cool - the so-called solar dimming (SDM) effect. In the Asian monsoon region, the SDM effect by aerosol can produce differential cooling at the surface reducing the meridional thermal contrast between land and ocean, leading to a weakening of the monsoon (Ramanathan et al. 2005). On the other hand, absorbing aerosols such as black carbon and dust, when forced up against the steep slopes of the southern Tibetan Plateau can produce upper tropospheric heating, and induce convection-dynamic feedback leading to an advance of the rainy season over northern India and an enhancement of the South Asian monsoon through the Elevated Heat Pump (EHP) effect (Lau et al. 2006). In this paper, we present modeling results showing that in a coupled ocean-atmosphere-land system in which concentrations of greenhouse gases are kept constant, the response of the South Asian monsoon to dust and black carbon forcing is the net result of the two opposing effects of SDM and EHP. For the South Asian monsoon, if the increasing upper tropospheric thermal contrast between the Tibetan Plateau and region to the south spurred by the EHP overwhelms the reduction in surface temperature contrast due to SDM, the monsoon strengthens. Otherwise, the monsoon weakens. Preliminary observations are consistent with the above findings. We find that the two effects are strongly scale dependent. On interannual and shorter time scales, the EHP effect appears to dominate in the early summer season (May-June). On decadal or longer time scales, the SDM dominates for the mature monsoon (July-August). Better understanding the physical mechanisms underlying the SDM and the EHP effects, the local emission and transport of aerosols from surrounding deserts and arid-regions, and their interaction with monsoon water cycle dynamics are important in providing better prediction and assessment of climate change impacts on precipitation of the Asian monsoon land regions.

Keywords: monsoon, aerosol, rainfall

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Seasonal variation of tropical cyclone rainfall associated with ENSO

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Tropical cyclone (TC) produces a lot of rainfall and strong winds during its passage. The formation of TC has an evident seasonal variability and is affected by the phase of ENSO (El Nino Southern Oscillation). Usually numbers, locations, tracks, or intensity was utilized to represent the activity of TC. In this study, averaged TC rainfall is introduced by using daily station data. Rainfall also has a seasonal variability and is related to ENSO. We distinguished TC rainfall from total rainfall, it makes possible to reveal the contribution of TC within the total rainfall and the relation to ENSO respectively. TC rainfall is defined when TC is located within the threshold distance from the station. Threshold is determined by the coverage, where averaged TC rainfall decrease according to the distance from station. In excess of 1000 km radius, TC rainfall becomes nearly constant with distance. Zonal distribution of averaged TC rainfall is made along 7 N to 13 N over western Pacific. TC rainfall has a maximum around October to November and its ratio reaches up to 40% at Guam. TC rainfall increases from summer (JJA) to winter (DJF) prior and around mature El Nino and tends to shift eastward during El Nino, compared to all year average. The increase of total rainfall can be explained by the increase of TC rainfall during summer prior to mature El Nino. On the following autumn (SON), the decrease of total rainfall can be explained by the decrease of TC rainfall over west of 140 E. However, over east of 140 E, total rainfall does not show a significant change, because increase of TC rainfall cancels the decrease of non TC rainfall. TC rainfall contribution to total rainfall associated with ENSO was small on other seasons.

Keywords: tropicalcyclone, rainfall, monsoon

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JMS011 **Oral Presentation** **1052**

Major Modes of Asian-Australian Monsoon Variability and their Strengthening Relationship with ENSO

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The Asian-Australian monsoon (A-AM) system covers one third of the global tropics and subtropics between 40E and 160E. Two major modes of seasonally evolving year-to-year variability of the A-AM system were identified by applying Season-reliant EOF (S-EOF) analysis. The first exhibits a prominent biennial tendency and concurs with the turnabout of warming to cooling in the eastern-central Pacific, and the second leads the Pacific warming by one year, providing a precursor for El Nino/La Nina development. We propose that the remote El Nino forcing, monsoon-warm pool ocean interaction and influence of the monsoon annual cycle are three factors that are fundamental to understanding the behavior of the leading mode. The monsoon-ocean interaction is characterized by a positive feedback between the off-equatorial moist atmospheric Rossby waves and the underlying SST dipole anomalies. The monsoonal annual cycle determines how the atmosphere responds to the remote El Nino forcing and the nature of the local monsoon-ocean feedback. Our analyses reveal that the overall coupling between the A-AM system and ENSO has been strengthened since the late 1970s, because the positive correlations between the ENSO and the western North Pacific, East Asian, and Indonesian monsoons have been all enhanced in the developing, maturity and decaying phase of ENSO, which overrides the weakening of the Indian monsoon-ENSO anticorrelation during the developing phase of ENSO. In the recent 25 years, the leading mode shows a weakening biennial tendency and the second mode provides a strong precursory signal for ENSO warming. These interdecadal changes are attributed to the increased amplitude and periodicity of ENSO. The amplified ENSO variability has reinforced the monsoon-ocean interaction and the Indian and Pacific Ocean coupling, thereby fortified their impacts on the western North Pacific, East Asian, and Indonesian monsoons in all phases of ENSO events; meanwhile the enhanced ENSO forcing and monsoon-ocean interaction bring on stronger westerly monsoon across South Asia during the developing phase of El Nino, thus weakening the Indian summer monsoon-ENSO anticorrelation.

Keywords: monsoon, enso, asian australian

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Monsoon Simulations with a High Resolution Global Model

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A high-resolution global climate model with a horizontal resolution of about 20 km has been developed and utilized to simulate seasonal mean anomalies, Madden and Julian oscillation (MJO), synoptic transients, and diurnal cycle. The tropical seasonal mean anomalies such as the difference between El-Nino and La Nina means are not much affected by the change of horizontal resolution, which indicates that the seasonal means are mainly controlled by the physics. However, shorter-term variations with time scales shorted than a month appear to be very much affected by horizontal resolution of the model. The intensity of MJO is reasonably well simulated by the high-resolution model, although the phase relationship between the SST and precipitation of MJO time scale is not close to the observation. It is suggested that the failure of the phase relationship is mainly by lacking of air-sea interaction in the western Pacific. The transients are very well represented by the high-resolution model and the streamfunction tendency due to transient vorticity flux divergence is greatly improved by increasing the resolution, which affects the seasonal mean anomalies in the extratropics. Although the diurnal cycle is somewhat improved by increasing the resolution, there is still difficulty in simulating the diurnal cycle properly with the high-resolution GCM, mainly due to problems of current convective parameterization.

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JMS011 **Oral Presentation** **1054**

Long term deceleration of the Summer Monsoon and its Fingerprints on the Indian Rice Harvest

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Two independent coupled ocean-atmosphere general circulation model (OAGCM) studies support the hypothesis and simulations published earlier by Ramanathan et al. (PNAS, 2005) that radiative forcing by atmospheric brown clouds (ABCs) has decreased the summer-time north-south sea surface temperature (SST) gradient in the Indian Ocean; and the decrease in SST gradient in turn is the major forcing factor for the deceleration in the monsoon and the decrease in monsoon rainfall over India since the 1950s. We (Auffhammer, Ramanathan and Vincent, PNAS 2006) have subsequently coupled the simulations of the OAGCM with an agro-economic model and showed that the simulated decrease in monsoon rainfall by ABCs can account for an average annual 10% decrease in rice harvest during 1966-98, which is a decrease of about 5 million tons per year at current harvest levels. It is important to note that the annual rice harvest growth rate, which peaked at about 3% in the mid 1980s (following the Green Revolution of the 1960s), has almost leveled off now. We are now following up this interdisciplinary work and have coupled our agro-economic model with observed (not modeled) rainfall, temperature and surface solar radiation and illustrate the coupling between summer monsoon rainfall and rice harvest in various sub-regions of . One important aspect of our new study is that we make a distinction between intense rainfall (which has an increasing trend since the 1950s) and more moderate rainfall (which shows a strong negative trend since the 1950s) and partition their respective impact on rice production. The fundamental objective of our study is to provide a strong scientific foundation for understanding the impact of regional climate changes (rainfall, temperatures and solar radiation) on agriculture production.

Keywords: monsoon deceleration, monsoo rainfall trends, rice harvest

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JMS011 **Oral Presentation** **1055**

Performance of climate prediction models on annual modes of precipitation and its relation with seasonal prediction

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Knowledge of the models performance in simulating and forecasting seasonal mean states is necessary for assessing models capability in predicting seasonal anomalies. We assessed the performances on annual cycle (AC) in APCC/CliPAS and DEMETER models 21-year (1981-2001) hindcast products. These models consist of 13 coupled and 5 uncoupled ones. The metrics used for assessing mean states include the mean climate and the first two modes of annual variation, i.e., the solstice monsoon mode and the equinox asymmetric mode. The following questions are addressed: (1) How well do the current models forecast the annual mean and seasonal cycle? (2) What are the common biases in the coupled models and stand-alone atmospheric models forced by predicted SST? (3) Are the skills in forecasting the mean state and seasonal cycle related to the models skills in seasonal prediction? It is shown that the current coupled models can reproduce the annual mean and the leading AC mode of precipitation reasonably well, while they have difficulty to simulate the 2nd AC mode, especially over the Indian Ocean and western North Pacific (WNP). The uncoupled models have large positive biases in the leading AC mode over the WNP where the negative feedbacks from the atmosphere to ocean were missed. Over the WNP region, the most coupled models capture the mean and AC more realistically than uncoupled ones, but they tend to underestimate the precipitation amount and the interannual variability, thus degrading seasonal prediction skills. The assessments were extended to the important Asian sub-monsoon domains as well. Even though the coupled models have difficulty in capturing climatological intraseasonal variation, they can capture the climatological onset and withdraw dates realistically, especially over the Indian monsoon region. It is shown that the seasonal prediction skills are positively correlated with their performances on both the annual mean and annual cycle in the coupled climate models.

Keywords: annual modes of precipitation, seasonal prediction, monsoon prediction

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JMS011 **Oral Presentation** **1056**

Influence of Tropical Cyclone on the Estimation of Climate Variability in the Tropical Western North Pacific

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By estimating the differences between the original and TC-removed fields, this study reveals that TCs contribute significantly to the seasonal mean and the intraseasonal and interannual variance of 850 hPa vorticity along the TC tracks in the tropical Western North Pacific. Similar effect on the precipitation is also reported by showing examples in . While the low-frequency, large-scale circulation has clustering effect on TCs, the latter with large positive vorticity, which tend to occur in the positive vorticity background flow, significantly enhances the total strength of the positive vorticity. This TC contribution, which is not offset by the synoptic systems with weak negative vorticity, can therefore leave marked footprints in the climate signal and variability. This effect is not removed by long-term averaging and low-pass filtering, which are often used to retrieve the climate perturbations. This implies that the climate variability, as it is defined, is not contributed merely from the low-frequency large-scale fluctuations. Instead, the TC effect has to be taken into account to understand the climate variability in the tropical Western North Pacific. This result implies that the ensemble effect of TCs, at least in the statistical sense, has to be resolved in the climate model to obtain better simulation of climate variability in the TC-prone region such as the tropical Western North Pacific.

Keywords: tropical cyclone, climate variability, western north pacific

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JMS011 **Oral Presentation** **1057**

Seasonal variation of latent-heating profile over tropical monsoon areas described by TRMM-PR observations

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Large-scale distribution of latent heating profiles are investigated using a dataset of precipitation and latent heating derived from observations by Precipitation Radar (PR) on board the Tropical Rainfall Measuring Mission (TRMM). Precipitation observed by TRMM-PR is classified into four categories; warm rain (echo-top is lower than melting level), stratiform rain, convective rain, and anvil rain (echo-bottom is detached from surface). Rainfall other than the warm rain is classified into the last three categories, which includes not only rain but ice-phase precipitation. Latent heating is retrieved from PR observations (version 6 2A25 product of TRMM) using PRHeating profile algorism proposed by Satoh (2004) and revised by Katsumata. Distribution of warm rain is quite different from those of the other categories. Warm rain is strong over ocean and scarce over land, except several regions where summer monsoon is prevailing. In lower troposphere (~1.5 km ASL), stratiform (warm) rain causes evaporative cooling (condensation heating). As a result, net latent heating shows significant contrast between land and ocean, i.e., evaporative cooling is dominated in the former where warm rain is weak, and condensation heating by warm and shallow convective rain is dominated in the latter. In tropical monsoon area, land-sea heat contrast in the lower troposphere is most intensified after the onset of summer monsoon, when stratiform rain is strongest. In the mid-troposphere at ~ 5 km ASL, the maximum latent heating appears after the onset, and horizontal distribution of the heating is similar to OLR distribution. Latent heating by stratiform rain is larger than that by convective rain. In the upper troposphere at ~ 8 km ASL, latent heating is mainly ascribed to stratiform rain after the monsoon onset. A part of summer monsoon areas over land, i.e., Amazon basin and northeast Thailand, heating in pre-monsoon period is comparable to that after the onset. Over these areas, contribution of convective rain in the latent heating is larger in the pre-monsoon period than the monsoon period, because predominant raintype changes from deep convective to stratiform before and after the monsoon onset.

Keywords: latent heating, trmm, monsoon onset

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JMS011 **Oral Presentation** **1058**

Diagnosis and predictors of Indian monsoon intraseasonal variability

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The northward-propagating intraseasonal (3050 day) oscillation (NPISO) between active and break monsoon phases exerts a critical control on monsoon-season rainfall totals over the Indian subcontinent. Advances in detecting these events and comprehending the physical mechanisms behind them hold great potential for improving their predictability. While previous studies have attempted to extract active and break events from reanalysis data to elucidate a composite lifecycle, those studies have relied on first isolating the intraseasonal variability in the record (e.g., through bandpass filtering, removing harmonics, or empirical orthogonal function analysis). Additionally, the underlying physical processes previous studies have proposed have varied widely, both among themselves and with studies using general circulation models. We define a simple, physically based index for diagnosing NPISO events in observations and reanalysis. This index is the first to use unfiltered outgoing longwave radiation (OLR) observations and so does not rely on artificial processing methods. A composite NPISO lifecycle based on this index is remarkably similar to previous composites in OLR and surface winds. This demonstrates that careful consideration of an index eliminates the need for complex statistical methods to identify the intraseasonal oscillation. This study is also among the first to examine the NPISO using a long-period record of high-resolution sea-surface temperatures (SSTs) from the TRMM Microwave Imager. Application of our index to those SSTs demonstrates that SST anomalies exist in near-quadrature with convection, as suggested by recent coupled-model studies. Analysis of the phase relationships between atmospheric fields and SSTs indicates that the atmosphere likely forced the SST anomalies. The results of our lag-correlation analysis also suggest that the oscillation serves as its own most reliableand perhaps onlypredictor, and that India, not the equatorial Ocean, is the key terminus of the oscillation for predictability.

Keywords: intraseasonal oscillation, index, composites

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JMS011 **Oral Presentation** **1059**

How much do the Pacific and Indian Oceans affect onset of the South China Sea summer monsoon

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Based on the data of heat content in the upper ocean from multi-year Joint Environmental Data Analysis Center (1955-1998), reanalysis data from NCEP/NCAR (1951-1998) and meteorological indices from National Meteorological Centre of China (1951-1998), relationship of onset of the South China Sea Summer Monsoon (SCSSM) with heat content of the upper ocean in the warm pool area and the westernmost point of the subtropical high over the Pacific, and the zonal wind in the northern Indian Ocean was analysed by means of correlation-, composite-, wavelet- and cross wavelet-analyses. The results are as the following. (1) Before 1970, the correlation between the SCSSM onset date and heat content in the tropical western Pacific warm pool in March is poor, while the correlation between the SCSSM onset date and zonal wind and cross-equatorial airflow over the northern Indian Ocean is strong (coefficients: 0.70, -0.57) with confidence level over 99%. (2) After 1970, the correlation of the SCSSM onset date with the heat content of the upper western Pacific and the westernmost point of subtropical high over the western Pacific in April is strong (coefficients: -0.59, -0.51) with confidence level greater than 99%, while the correlation between the SCSSM onset date and zonal wind and cross-equatorial airflow over the northern Indian Ocean is very poor. It is concluded in terms of ocean effect that before 1970 the northern Indian Ocean plays important role in the onset of the SCSSM associated with strong westerly airflow from the northern Indian Ocean to the South China Sea caused by the contrast between lower sea temperature and higher land temperature in April, while after 1970 the western Pacific warm pool is dominant over the onset of the SCSSM by its greater heat content in the upper ocean causing airflow from the western Pacific to the South China Sea , especially during the period from 1977 to 1998.

Keywords: south china sea summer monsoo, western pacific indian ocean, subtropical high

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JMS011 **Oral Presentation** **1060**

MAHASRI the new international asian monsoon research project

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The MAHASRI (Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative) is the follow-on program of the GAME (GEWEX Asian Monsoon Experiment) Project in the WCRP which successfully finished in March 2005. It has been conducted also under GEWEX/WCRP, but closer collaboration with CLIVAR. The research period will be until 2015. Its objective is To establish hydro-meteorological prediction system, particularly up to seasonal time-scale, through better scientific understanding of Asian monsoon variability". Its scientific topics will include, atmosphere-ocean-land interactions in the Asian monsoon system, role of orography on monsoon rainfall, scale-interactions among diurnal, synoptic, intraseasonal and seasonal variability of Asian monsoon, Interactions of surface and boundary layer processes with convective cloud system, comparisons of hydro-meteorological characteristics among regional monsoon sub-systems, effect of human influences on hydro-meteorological variations in Asian monsoon regions, down-scaling and up-scaling for/with regional hydro-meteorological modeling and forecast, transferability of land-surface hydrological models and parameters for prediction of ungauged basins, incorporation of new technologies for observation and computation. It will facilitate and/or improve hydro-meteorological observations in Asian monsoon countries in conjunction with GEOSS, cooperate with CEOP-II by observations, data and hydrometeorelogical studies in Asian monsoon. The international observation is now planning as AMY08 (Asian Monsoon Yearm 2008) from April 2008 to March 2009 covering full monsoon annual cycle. It will also enhance capacity building for observation, analysis, data-integration and modeling, establish an integrated database.In the presentation, the diurnal cycle in the maritime continent region will be presented as an example of the multi-scale orographic/atmospheric interaction under monsoon environment.

Keywords: monsoon, hydrological cycle, rainfall

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JMS011 **Oral Presentation** **1061**

Low-frequency variability of the Indian Monsoon-ENSO relation and the Tropical Atlantic: The 'weakening' of the '80s and '90s

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The Indian Monsoon-El Nino Southern Oscillation (ENSO) relationship, according to which a drier than normal monsoon season precedes peak El Nino conditions, weakened significantly during the last two decades of the 20th century. In this work an ensemble of integrations of an Atmospherical General Circulation Model (AGCM) coupled to an ocean model in the Indian basin and forced with observed sea surface temperatures (SSTs) elsewhere is used to investigate the causes of such a weakening. The observed interdecadal variability of the ENSO-Monsoon relationship during the period 1950-1999 is realistically simulated by the model and a dominant portion of the variability is associated to changes in the tropical Atlantic SSTs in boreal summer. In correspondence to ENSO, the tropical Atlantic SSTs display negative anomalies south of the Equator in the last quarter of the 20th century and weakly positive anomalies in the previous period. Those anomalies in turn produce heating anomalies which excite a Rossby wave response in the Indian Ocean in both the model and in reanalysis data, impacting the time-mean monsoon circulation. The proposed mechanism of remote response of the Indian rainfall to tropical Atlantic sea surface temperatures is further tested forcing the AGCM coupled to the ocean model in the Indian basin with climatological SSTs in the Atlantic Ocean and observed anomalies elsewhere. In this second ensemble the ENSO-Monsoon relation is characterized by a stable and strong anticorrelation through the whole second half of the XX century.

Keywords: enso, teleconnection, variability

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JMS011 **Oral Presentation** **1062**

Monsoons as regime transitions of a Hadley cell: Moist dynamics in an aquaplanet GCM

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In simulations with an idealized aquaplanet GCM, the tropical mean meridional circulation undergoes rapid regime transitions in the course of a seasonal cycle. A transition in early summer is characterized by strengthening and broadening of the cross-equatorial winter Hadley cell, rapid relocation into the subtropics and intensification of precipitation, and reversals in the upper-level and lower-level winds. A reverse transition occurs in late summer. The simulated transitions resemble the onset (and end, at the reversed transition) of Earth's monsoons. Consistent with similar dry simulations (Schneider & Bordoni 2007), the rapid rearrangements of the circulation mark shifts in the leading balance of the vertically averaged zonal momentum equation, from regimes in which the eddy momentum flux divergence dominates near the center of the Hadley cell, to regimes in which the eddy momentum flux divergence is negligible and the mean momentum flux dominates. The summertime convergence zones form in the subtropics just equatorward of the lower-level moist static energy maximum, which is colocated with the boundary between the winter and summer cell. Factors controlling the exact location of these precipitation zones are examined and discussed. These results de-emphasize the traditional view of monsoons as circulations driven by land-sea contrast and identify feedbacks between the large-scale baroclinic eddies and the mean flow as fundamental dynamical mechanisms involved in monsoon dynamics.

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JMS011 **Oral Presentation** **1063**

Evaluation of summer monsoon intraseasonal variability in the DEMETER hindcasts

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The intraseasonal variability associated with the Asian summer monsoon as simulated by seven coupled general circulation models (CGCMs) are analyzed and validated against observations. The model hindcasts are produced by the DEMETER project. Each hindcast is an integration of six months starting from 1 February, 1 May, 1 August and 1 November and comprises an ensemble of nine members. All seven models have been run for a common period of 1980-2001. The focus is on the spatial and seasonal variations associated with the summer monsoon intraseasonal oscillations (ISO) of outgoing longwave radiation (OLR), their large-scale organization, propagation characteristics, the air-sea coupling, their deterministic predictability and implications on seasonal predictability. A multi-variate Local Mode Analysis (LMA, essentially a complex EOF analysis over a window of 90 days moving over the 180 days of hindcasts) has been utilized in order to evaluate the above characteristics of ISOs in the hindcasts against observations. Most models have problems in simulating large-scale organized perturbations of the convection. In addition, perturbation patterns are more variable from one intraseasonal event to another compared to observation. However, most models do exhibit some form of northeastward propagation of the perturbations over the Indian Ocean. Realistic periods of the modes (25-35 days) are produced in a few models, while most models produce shorter periods (20-25 days). Models with poor seasonal cycle tends to have larger biases in the northeastward propagation and organization. One possible source of deficiency in organizing intraseasonal large-scale convective perturbation could be the air-sea interaction. The analysis of the nature of coupling in the hindcasts indeed shows that most models simulate too weak SST perturbations and systematic phase quadrature between OLR and SST, indicative of a slab-ocean-like response of the temperature to surface flux perturbations. Simulation done with the same AGCM and different OGCMs tend to have similar biases of the simulated ISOs, indicative of the importance of atmospheric processes in defining the nature of the intraseasonal SST perturbation. Mainly because of their relatively coarse vertical resolution, the different OGCMs used are however limited in their ability to represent intraseasonal processes, such as warm layer formation, which are important for realistic simulation of the SST perturbation and feedback at intraseasonal time-scales. This may explain the too small SST amplitude and the relatively similar behavior for the different OGCMs. Evaluation of the predictability at the ISO time scale (10-50days) is also performed on the basis of pentad mean OLR maps. Results show a better predictability in the summer (1 May initial conditions) hindcasts compared to the winter hindcasts (1 November initial conditions). This is possibly due to the better predictions and consistency among all ensemble members of the strong seasonal cycle and the embedded ISOs in summer compared to the weaker seasonal cycle in winter. Other intraseasonal and seasonal predictability studies are also presented with an emphasis on the influence of large-scale organized ISO perturbations on the regional seasonal evolution of the precipitation at particular location.

Keywords: intraseasonal perturbations, coupled model, hindcast

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JMS011 **Oral Presentation** **1064**

Influence of Aerosols on Convective Cloud Water/Ice and Precipitation Simulated with McRAS upgraded with Physics of Aerosol Indirect Effect (AIE)

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Using ARM-SCM data, Sud and Lee employed the Microphysics of clouds with the Relaxed Arakawa-Schubert Scheme (McRAS) was upgraded with physics of aerosol indirect effects (AIE) of water clouds. Thusly upgraded McRAS-was evaluated for its ability to simulate the vertical distribution of precipitation rate, and cloud-optical properties. The new AIE module consisted of i) Fountoukis and Nenes (2005) aerosol activation scheme; ii) Seifert and Beheng (2001) autoconversion and accretion physics suitably modified for the coarse resolution of a GCM; and iii) Khvorostyanov and Curry (1999) parameterization for effective radius (reff) of cloud drops and performs aerosol cloud interaction prognostically even inside the convective towers. Recently AIE was further upgraded to include Liu and Penner (2005) microphysics of ice-clouds. The entire complex was re-evaluated using 3-year ARM SGP SCM data. The simulated cloud optical thickness, Cloud Particle Number Density (CPNC), reff, and precipitation rates validated well against the ARM SGP data. SCM simulations also showed that cloud water/ice accretion responds realistically to aerosol species and mass concentration that was previously evaluated for water clouds only. The influence of AIE on the boreal summer season convection was simulated in some selected regions of South-East Asia with and without AIE. The AIE physics is able to capture most of the observed impacts of aerosol-cloud interactions. Some preliminary results of the influence of aerosols on moist convection will be explored. Its readiness for GCM use will also be discussed.

Keywords: aerosol, monsoon, climate

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JMS011 **Oral Presentation** **1065**

Broad scale Australian monsoon index and its variability

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A broad scale Australian monsoon index (AUSMI) is defined by using 850hPa zonal wind averaged over the area (110-130E, 15S-5S). This index reflects well monsoonal rainfall variability over the Australian and maritime continent. It can capture seasonal cycle, intraseasonal oscillation, interannual variability and interdecadal variability of Australian monsoon. The interannual variability of the Australian monsoon onset date is consistent with previous studies that were defined by using rainfall and wind data at Darwin. Also found is the significant negative correlation between Australian summer monsoon onset date and the seasonal (DJFM) mean rainfall anomalies. That is, an early (late) onset is accompanied by a strong (weak) Australian summer monsoon. The climatological mean Australian summer monsoon starts around middle December. The onset has large interannual variability, on the other hand, the withdraw dates tend to phase-locked to the seasonal cycle. The AUSMI is useful in representing interannual variability of the Australian summer monsoon and monitoring its day-to-day variation.

Keywords: australian, index, onset

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JMS011 **Oral Presentation** **1066**

Evolution of the summer monsoon rainfall in South America: role of soil moisture, surface temperature, and topography

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A relationship between peak summer monsoon rainfall in central-east , which is part of the South American monsoon core region, and antecedent conditions in spring (early season) is disclosed through diagnostic analysis using observed surface temperature and precipitation data. Rainfall in this region during part of spring holds significant inverse correlation with rainfall in peak summer, especially during ENSO years. A surface-atmosphere feedback hypothesis is proposed to explain this relationship: low spring precipitation leads to low spring soil moisture and high late spring surface temperature; this induces a topographically-enhanced low-level anomalous convergence and cyclonic circulation over Southeast Brazil that enhances moisture flux from northern and central South America into central-east Brazil, setting up favorable conditions for excess rainfall. Antecedent wet conditions in spring lead to opposite anomalies. The main links in this hypothesis are confirmed through correlation analysis of observed data: spring precipitation is negatively correlated to late spring surface temperature in central-east , and late spring surface temperature in southeast is positively correlated with peak summer monsoon precipitation in central-east . The intermediary links of the surface-atmosphere feedback are tested in sensitivity experiments with the regional model RegCM3. These experiments confirm that the proposed links are possible: reduced soil moisture in central-east is shown to increase surface temperature and produce a cyclonic anomaly over southeast , as well as increased precipitation in central-east . A crucial role of the mountains of Southeast Brazil in anchoring the patterns of intraseasonal variability, and sustaining the dipole-like precipitation mode observed over South America is suggested by the experiments. The low predictability of monsoon rainfall anomalies in central-east Brazil during austral summer might be partially ascribed to the fact that the models do not reproduce well the topographical features and the land-atmosphere interactions that are important for the variability in that region.

Keywords: intraseasonal variability, land atmosphere interaction, predictability

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JMS011 **Poster presentation** **1067**

South American climatological Monsoon Index

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A large-scale South American monsoon index was determined based on Combined Empirical Orthogonal Functions (Combined EOF). For this purpose we use satellite precipitation from the Global Precipitation Climatology Project (GPCP) and NCEP-NCAR reanalysis of the following fields: specific humidity, air temperature and zonal and meridional components of the wind in 850 hPa. The method of Combined EOF captured very well the establishment of the monsoon regime, its interannual and intra-seasonal variability when compared with other methods the literature.

Keywords: south america monsoon, monsoon index

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JMS011 **Poster presentation** **1068**

Numerical Simulation of precipitation and temperature over southeast of Iran using RegCM3 Climate Model

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Seasonal Prediction and modeling of the southeast of Iran is highly complicated; because of the influence of Indian monsoon and Complex geographical conditions including coastlines, Oman Sea, desert area and mountainous area. As the regional climate models consists from different numerical schemes for parameterization some physical process such as convection, topography, radiation and subgrid scale process, so they need to be calibrated in the area under study. In this paper RegCM3 regional climate model has been used for simulation of 1995 summer precipitation and temperature. According to the high contribution of the convective rainfalls in summer precipitation of the southeast of Iran, four convection schemes including Grell-As, Grell-Fc, Kuo and Emanuel have been selected in this study. Simulations have been done with 50 km spatial resolution over three provinces located on the southeastern part of Iran including Sistan-Bluchestan, Hormozgan and Kerman using NCEP reanalysis data. Results show that skill of the model in monthly temperature simulation is highly acceptable. Using Emanuel Scheme overall temperature Bias and relative error are to 3◦c and %0.9, respectively. But Skill of model isn't so good for monthly precipitation. The minimum bias and relative error with Emanuel scheme are 5.5 mm and %35.7, respectively.

Keywords: numerical climate modeling, monsoon convection scheme, observed data

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JMS011 **Poster presentation** **1069**

Upper tropospheric geopotential height gradient from Northern Subtropic to Southern Subtropic and the Indian summer monsoon variability

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Serious concern has been raised regarding declining trend in summer monsoon rainfall over India since 1960s notwithstanding increased evaporation associated with global warming. During boreal summer, there are large-scale reorganization/changes in the subtropical anticyclones and the area of convergence over the boarder region of Afro-Eurasian land mass and Indo-Pacific Ocean. Outflows from southern subtropical highs after crossing the equator, from subtropical high over northern Africa-Arabia-Iran-Iraq-Afghanistan-Pakistan-Northwest India, and from northern Pacific subtropical anticyclone merge together over Arabian sea, Bay of Bengal and southwestern North Pacific Ocean and the combine airflow passes through the passage of the low pressure area between Tibet-Himalaya highlands and the western North Pacific subtropical ridge which eventually merges with the northern mid latitude westerlies, northeast of Korea-Japan latitudes (~ 40 N). Low-level cross equatorial flow from the southern to northern hemisphere occurs over western Equatorial Indian Ocean. Initially the depth of the flow is shallow (upto 850 hPa) and confined to the south Arabian sea, Bay of Bengal, southeast China and east China. With the advance of the season the circulation spreads over north Arabian Sea, extreme North West India, the whole Indian subcontinent, southeast China, eastern and central China, Korea and Japan and the depth increases to 700 hPa to 500 hPa by July. The circulation starts receding in depth and spatial spread from 1st week of August and the ITCZ and the equatorial trough are back to their normal position by the end of November. During June-July-August the outflows from upper tropospheric anticyclone over Afro-Eurasian landmass and North Pacific Ocean (covering Tibet-Himalaya highlands) after crossing the equator merge with the southern mid-latitude westerlies. The sole objective of the present study is to examine if there is any change in the intensity of the anticyclones of the two hemispheres and its effect on the Indian Monsoon. The geopotential height data of the NCEP-NCAR reanalysis is used in the present study. At 300, 200 and 100 hPa isobaric levels rectangular area showing of the subtropical highs over Afro-Eurasian landmass and Indo-Pacific ocean has been demarcated. The time series (1949-2004) of monsoon monthly geopotential height for the rectangular box has been prepared from the NCEP-NCAR 2.5 square grids data. Fluctuation analysis of the geopotential height of the northern subtropic high, Southern subtropic high as well as the slope from northern subtropic to southern subtropic has been carried out. In recent years numerous studies have attempted to determine the association between subtropical anticyclones and the summer monsoon. Analysis of the geopotential height was carried out for 300, 200 and 100 hPa isobaric levels but results are discussed for the significant cases. June- Geopotential height of 300 hPa level over both the subtropics showed almost comparable linear increasing trend. The difference between the north subtropic and south subtropic is significantly correlated (CC=0.41). July- All the three levels (300, 200 and 100 hPa) showed linear increasing trend over both the hemispheres. The difference between mean geopotential height of the three levels from the northern hemisphere to southern hemisphere showed correlation of 0.66 with the all-India July rainfall series. August- Geopotential height difference of only 200 hPa level from northern subtropic to southern subtropic showed significant correlation (CC=0.43). September- Difference between mean geopotential heights of the three levels from northern subtropic to southern subtropic showed correlation of 0.55. Monsoon season- The seasonal mean series has been obtained from the monthly data of the three levels that is 300, 200 and 100 hPa for both the hemispheres. Increasing trend is amply clear in both the series. However, the difference in the geopotential height from northern subtropic to southern subtropic has shown decreasing trend which paralleled the all-India monsoon rainfall series. The two parameters are closely related (CC=0.68). The geopotential height of the southern subtropic is rising at a faster rate than its northern counter part, which means northern subtropic is warming at a higher rate (0.212 C/10-year) than the northern subtropic (0.188 C/10-year). The resultant effect of this asymmetric temperature fluctuation over the two hemispheres is the weaker monsoon circulation and rainfall activity over India. Conclusively over eastern hemisphere there is sharp decline in the slope of the geopotential height of the 300, 200 and 100 hPa isobaric levels from northern subtropic to southern subtropic during monsoon period. This is indicative of reduced exchange of mass and moisture between northern hemisphere and southern hemisphere. The result is vindicated by the decreasing trend in the all-India monsoon rainfall from 1962.

Keywords: subtropicalhigh, indiansummermonsoon, globalwarming

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JMS011 **Poster presentation** **1070**

Link between trends in land precipitation and tropical SST gradient: Implications for aerosol forcing effects

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Land precipitation trend from 1951 to 2002 shows widespread drying between 10S to 20N but the trend from 1977 to 2002 shows a recovery. Interestingly, SST trend in the tropics from 1951 to 2002 is characterized by less NH warming and greater SH warming, while the trend from 1977 to 2002 shifts to greater NH warming and less SH warming. This analysis, strengthened by a set of CCM3 experiments, indicates that land precipitation is more vulnerable to trends in tropical SST gradient than to an overall tropical warming. In case of increasing greenhouse gases (GHGs) in the PCM (coupled model), zonal annual mean land precipitation is not significantly perturbed, perhaps because increasing GHGs induces relatively-uniform SST increases in the tropics. Introducing global aerosol forcing into the CCM3 with SSTs held to their climatological values produces small amounts of zonal/annual mean land precipitation change as well. Significantly bigger changes are simulated by imposing observed1951-2002 SST trends in the CCM3. The observed1951-2002 SST trends have substantial north-south gradients in the tropics while the magnitude of the average warming trend is only comparable to the uniform warming magnitude in the GHG PCM experiment. The implication is that aerosols, because of their spatial heterogeneity, can potentially have a major impact on land precipitation by perturbing SST gradient in the tropics. The surface solar radiation variation due to aerosols from 1950 to 2000 was preliminarily computed over the tropical ocean, and the results show that the meridional surface solar radiation trend pattern is quite similar to the SST trend pattern in the Pacific and Indian Oceans but not in the Atlantic, thereby pointing to natural variability and aerosols together in having driven trends in SST gradient.

Keywords: aerosol, precipitation, sst

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JMS011 **Poster presentation** **1071**

Formation of convection center at the Bay of Bengal: AGCM experiments

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This paper discusses the formation process of the distinct convection center around the northeast coast of the Bay of Bengal during the Asian summer monsoon. Xie et al. (2006) emphasized the influence of the narrow mountains over the Indochina Peninsula on the rain distribution of the Bay of Bengal. He suggested the importance of the orographically induced mesoscale convective system. However, we succeeded in reproducing the rain distribution of the Bay of Bengal using the atmospheric general circulation model (AGCM) with the resolution of T106L56 (horizontal resolution ~1.1, 56 vertical layers) without including detailed topography of such narrow mountains. This means that the mesoscale topography and the induced mesoscale atmospheric circulation are not essential for forming the convection center in the Bay of Bengal. The original AGCM (CCSR/NIES/FRCGC AGCM), which includes the prognostic Arakawa-Schubert scheme as a cumulus parameterization, could not reproduce the convection center at the northeast of the Bay of Bengal. The AGCM had a peak of precipitation at the east of Ceylon. To improve it, we adopted the cumulus suppression (CS) as an additional condition of the Arakawa-Schubert cumulus parameterization. CS permits cumulus convection only when the environmental relative humidity averaged in the modeled cumulus cloud exceeds 80%. In the experiment with the CS (CS run), the cumulus convection was well suppressed at the east side of the Indian subcontinent, because the westerly at leeward of the Indian subcontinent was dried owing to the orographic descending motion. As a result, the peak of precipitation at the east of Ceylon disappeared. Meanwhile, the CS intensified the convective available potential energy (CAPE) in the tropics. The Bay of Bengal also had enough CAPE associated with the convectively unstable condition. The CS run also well simulated the monsoon easterly wave. The disturbances, which come from the South China Sea and Indochina, developed over the Bay of Bengal and brought the heavy rain. The orographically induced grid-scale ascending motion at the northeast coast of the Bay of Bengal triggered the disturbances to develop within the Bay. The enough CAPE and the proper triggering of cumulus convection are sufficient to reproduce the realistic rainfall distribution in the Bay of Bengal.

Keywords: monsoon, agcm, convection

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JMS011 **Poster presentation** **1072**

Effect of climate change in the late 1970S on tropospהereic biennial oscillation

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Tropospheric Biennial Oscillation (TBO) is the tendency of a strong monsoon to be followed by a weaker one and vice-versa for Asian-Australian monsoon system. This biennial Oscillation includes the active participation from Indian and Pacific Oceans and South Asian monsoon. After the climate shift of late 1970s, the Monsoon ENSO relationship has undergone considerable changes. The present paper investigates whether this shift has any major influence on the TBO phenomena. The TBO cycle for the strong minus weak monsoon year composites in the presence and absence of ENSO, before and after the climate shift has been analysed. Empirical Orthogonal Function (EOF) analysis is carried out for sea surface temperature (SST) anomalies and velocity potential at 200 hpa to identify the dominating modes of variability during these two periods. The number of TBO years remains almost the same before and after the climate shift. But EOF analysis identifies EOF2 of global SST over Indian Ocean as TBO mode and the percent of total variance increases after the climate shift. The next EOF is similar to that of the TBO anomalies in the absence of ENSO and the variance pattern also increases after this shift. Velocity potential also has similar type of increase in total TBO variance. Thus after the climate shift, in contrary to the ENSO variance decrease, the TBO variance increases, especially in the Indian Ocean. The composite analysis of SST, lower level wind and velocity potential at 200 hpa shows the TBO cycle in the Indian Ocean and Asian monsoon area in the absence of ENSO. After the climate shift the TBO cycle in seasonal anomalies remains same with and without Elnino. The role of ENSO in this biennial cycle gets reduced after this climate shift. The seasonal movement of anomalies is also different for non-ENSO TBO years after the climate shift. The biennial cycle of anomalies is almost absent in the pacific after the shift. The ENSO-TBO years are reduced considerably after the shift due to the decreased biennial tendency of ENSO.

Keywords: tbo, enso, monsoon

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JMS011 **Poster presentation** **1073**

The interaction between the Meiyu precipitation and the Subtropical Anticyclone

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One of the dominated rain-producing phenomenon which represents the local rainfall maximum during the early summer is called Mei-yu in China and Baiyu in Japan. Accompanied the occurrence of the continuous Meiyu precipitation, it is often found the westward movement of the Western Pacific Subtropical Anticyclone (WPSA) at 500hPa and eastward extension of the South Asia Anticyclone (SAA) at 100hPa. Spatially the rain belt is distributed along the northwest side of the WPSA. In present study the Mei-yu rainfall case of 20-30 June 1999 is selected to discuss the interaction between the Mei-yu rainfall and the subtropical anticyclone. During this 10-day period, the rain belt stretch from the lower reaches of the Yangtze River Valley of China to the Japan peninsula, the WPSA move obviously westward. Meanwhile a 100hPa anticyclone cell is located right over the eastern China, which exhibits as the eastward extension of the 100hPa SAA. The eastward extension of the SAA causes the divergence and ascent motion over 30N latitudinal area while the convergence and descending motion over 23N latitudinal area, thus resulting in the enhancement of the local negative vorticity at the low-middle troposphere. Following the eastward extension of the SAA, the 500hPa WPSA moves westward to inland and leads the southwestly prevailing along the north side of the WPSA which supplying the rich water vapor. On the other hand, the latent heating from the Meiyu precipitation further intensifies the southerly at the lower layer and northerly at the higher layer and results in a secondary circumfluence. Such a secondary circumfluence further induces the WPSA moving westward. Thus the westward moving and strengthening of the WPSA enhance the west jet at about 35N. The enhanced west jet leads the rain belt moving eastward to the Japan, and prevents the WPSA moving northward. Following the eastward shift of the rain belt, the 500 hPa WPSA becomes weak due to the weakened latent heating over the Yangtze River valley, and moves out of the continent.

Keywords: subtropical, high, meiyu

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JMS011 **Poster presentation** **1074**

Relationship between Atmospheric Conditions at Dhaka, Bangladesh, and Rainfall at Cherrapunjee, India

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To improve flood forecasting, understanding the atmospheric conditions associated with severe rainfall is crucial. We analysed the atmospheric conditions at Dhaka, Bangladesh, using upper-air soundings. We then compared these conditions with daily rainfall variations at Cherrapunjee, India, which is a main source of floodwater to Bangladesh, and a representative sample of exceptionally heavy rainfall events. The analysis focussed on JuneJuly 2004. June and July are the heaviest rainfall months of the year at Cherrapunjee. July 2004 had the fourth-heaviest monthly rainfall of the past 31 years, and severe floods occurred in Bangladesh. Active rainfall periods at Cherrapunjee corresponded to breaks in the Indian monsoon. The monsoon trough was located over the Himalayan foothills, and strong westerly winds dominated up to 7 km at Dhaka. Near-surface wind below 1 km had southerly components, and the wind profile had an Ekman spiral structure. The results suggest that rainfall at Cherrapunjee strongly depends on the near-surface wind speed and wind direction at Dhaka. Lifting of the near-surface southerly airflow by the Meghalaya Plateau is considered to be the main contributor to severe rainfall at Cherrapunjee. High convective available potential energy (CAPE) also contributes to intense rainfall amounts.

Keywords: heavyrain, bangladesh, northeastindia

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JMS011 **Poster presentation** **1075**

Simulation of Interannual Variability of Indian Summer Monsoon in AGCMs and the role of SST-Rainfall Relationship

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It is well known that the simulation of the interannual variation of the Indian summer monsoon rainfall (ISMR) by Atmospheric General Circulation Models (AGCMs) remains a challenging problem. The present analysis of the simulations of AMIP 2 and of another AGCM has shown that the errors are not random. Almost all the models are able to simulate the correct sign of the ISMR anomaly in years in which it is associated with El Nino or La Nina (such as the excess ISMR associated with La Nina of 1988) but almost no model can simulate the sign of the ISMR anomaly when not associated with ENSO (such as for the excess monsoon season of 1994 which occurred despite a weak warm phase of ENSO). Recently, some studies have suggested that the poor skill of AGCMs in simulating the interannual variation of the monsoon rainfall can be attributed to the poor skill in simulation of the SST-rainfall relationship over the Indo-Pacific regions. This relationship in the AMIP2 simulations is examined. We also examine the cause of poor simulation of the 1994 summer monsoon in all the AGCMs.

Keywords: indian monsoon, interannual variability, air sea interaction

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JMS011 **Poster presentation** **1076**

The relationship between the Asian monsoon and the ITCZ migration over the maritime continent in the boreal summer

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The relationship of the Asian monsoon and the ITCZ migration over the maritime continent in the boreal summer is studied through some sensitivity experiments using the GCM (GSM T63L40) of Japan Meteorological Agency (JMA). First, the model is run from April 1st until June 30th under the SST (solar) which is fixed at the value of April 1st and the results are compared with the control run. The experiments indicate that the Asian summer monsoon and the ITCZ migration relate each other through the seasonal marches of the land-sea thermal contrast and SST. The land-sea thermal contrast induces low-level wind surrounding the Eurasian continent, and makes a primary contribution to the formation of the Asian monsoon westerlies. Then, it induces the northward ITCZ shift from the northern part of the maritime continent. The seasonal march of the SST, induces the ITCZ jump from the southern to the northern hemisphere, strengthens the local Hadley circulation, and then enhances the monsoon westerlies through effective transport of the absolute angular momentum. Thus, the seasonal march of the SST induces the ITCZ jump from the maritime continent towards the South China Sea (SCS). The SCS monsoon, a part of the Asian summer monsoon, is regarded as main trigger of the ITCZ shift over the maritime continent. Besides that, as recognized in some previous studies, the SCS SST may affect the intensification of the SCS monsoon. Then, sensitivity experiment to the SST over the SCS region is made to evaluate the coupling constant between the Indian and the SCS monsoon system. The model is run from April 1st until June 30th under the SST (solar) which 0.5K SST anomaly is inserted over the SCS region, and the result is compared with the control run. The result shows that the Indian monsoon westerlies strengthen the SCS monsoon through the Convection-Wind-Evaporation feedback mechanism, but weaken it through the reduction in the SCS SST. However, the GCM study suggests that the former effects are much larger than the latter. The strength of the SCS monsoon correlates to the enhanced precipitation over there that may induce the northward shift of the ITCZ from the maritime continent toward the SCS.

Keywords: itcz, monsoon, maritime continent

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JMS011 **Poster presentation** **1077**

Multiscale variability of the flow during the 2004 North American monsoon experiment

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The 2004 North American Monsoon Experiment (NAME) provided an unprecedented observing network for studying the structure and evolution of the North American Monsoon. This paper focuses on multiscale characteristics of the flow during NAME from the large scale to the mesoscale using atmospheric sounding data from the enhanced observing network. The onset of the 2004 summer monsoon over the NAME region accompanied the typical northward shift of the upper-level anticyclone or monsoon high over northern Mexico into the southwestern U.S., but in 2004 this shift occurred slightly later than normal and the monsoon high did not extend as far north as usual. Consequently, precipitation over the southwestern U.S. was slightly below normal, although increased troughiness over the Great Plains contributed to increased rainfall over eastern New Mexico and western Texas. The first major pulse of moisture into the Southwest occurred around 13 July in association with a strong Gulf surge. This surge was linked to the westward passages of Tropical Storm Blas to the south and an upper-level inverted trough over northern Texas. The development of Blas appeared to be favored as an easterly wave moved into eastern Pacific during the active phase of a Madden-Julian Oscillation. On the regional scale, sounding data reveal a prominent sea breeze along the east shore of the Gulf of California, with a deep return flow as a consequence of the elevated Sierra Madre Occidental (SMO) immediately to the east. Subsidence produced a dry layer over the Gulf, whereas a deep moist layer existed over the west slopes of the SMO. A prominent nocturnal low-level jet was present on most days over the northern Gulf. The diurnal cycle of heating and moistening Q1 and Q2 over the SMO was characterized by deep convective profiles in the mid-to-upper troposphere at 1800 LT, followed by stratiform-like profiles at midnight, consistent with the observed diurnal evolution of precipitation over this coastal mountainous region. The analyses in the core NAME domain are based on a gridded dataset derived from atmospheric soundings only, and therefore should prove useful in validating reanalyses and regional models.

Keywords: monsoon, precipitation, gulf surge

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JMS011 **Poster presentation** **1078**

Observations of Meso-Scale Features of Pre- and Mature Summer Monsoon Cloud Systems over Bangladesh

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Bangladesh and its surrounding area are known as the highest rainfall areas in the world. Various types of disasters such as flash floods, tornadoes, and down bursts occur in this area associated with the meso-scale cloud systems. However, because of the lack of data with high temporal and spatial resolution, it has been difficult to investigate the meso-scale features of cloud systems over this country. To make a breakthrough in this research status, several types of meteorological instruments capable of observations with high temporal and spatial resolutions were introduced for the first time in this area to capture the meso-scale structure of rainfall systems. We installed an automatic weather station (AWS) at Dhaka and automatic raingauges (ARG) in 6 locations in this country. And also, we utilized the weather radar of Bangladesh Meteorological Department (BMD) to capture the spatial pattern of the meso-scale systems with heavy rainfall. Using these data, meso-scale characteristics of disturbances that bring about atmospheric disasters in pre- and mature monsoon seasons in Bangladesh are analyzed. From the radar image in 2001 summer (16-18 July), a striking feature of the systematic diurnal variation in this area was elucidated. In these three days, the diurnal evolution of convective activity was remarkably similar to each other, implying that this pattern can be understood as a typical response of local cloud systems to the diurnal variation of insolation under some summer monsoon situation. In the central to south-western part of country, a lot of scattering small echoes develops in the daytime. From evening time, relatively well organized echoes appear in the north-eastern part of country. They form initially linear shape along the Meghalaya mountains, and later they spread over the northeastern most area of Bangladesh with stratiform stractures. The ARG data show the difference of characteristics of rainfall between pre- and mature monsoon seasons. The short intense downpour tends to occur more frequently in the pre-monsoon season than the mature monsoon season. The pre-monsoon rainfall also has clear diurnal variation with peak that is more strongly concentrated in time. In the northern part the rainfall peak is found in midnight-early morning, while it is observed in the daytime in central to western part of country. Two disaster cases caused by meso-scale disturbances are analyzed. Although they occur in the same season, the structure of cloud systems was largely different from each other. The disturbance brought about tornadoes on 14 April 2004 consisted of many spherical shaped cloud systems with about 20km size. On the other hand, another one that caused the tragic river water transport accident on 23 May 2004 had meso-scale rain band structure. The latter case was captured by the AWS located at Dhaka. Sudden temperature, wind and pressure change was observed clearly, showing typical structure of convective rain bands.

Keywords: bangladesh, meso systems, diurnal variation

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JMS011 **Poster presentation** **1079**

Monsoon circulations and associated subtropical convergence zones

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Features of monsoon circulations and associated subtropical convergence zones (STCZs) simulated by an AGCM (T106L56: a primitive equation spectral model which has 56 sigma-levels and triangular spectral truncation at wave-number 106) are studied. The 24-year integration from 1979 to 2002, by the model under constrains with observed sea-surface temperature and sea-ice distribution, is used for this study. The detailed analysis is made for the typical case of the Meiyu-Baiu frontal zone (MBFZ), the South Indian Ocean convergence zone (SICZ) and the South Atlantic convergence zone (SACZ) selected from the simulation in 1985-1996. The Asian summer monsoon circulation and MBFZ, which extends northeastward from the southern part of China to Japan, are reasonably reproduced by the model. The confluence and convergence of the Indian monsoon westerly with the easterly trade wind around the North Pacific subtropical anticyclone are the essential condition for the formation of MBFZ. The Asian winter monsoon circulation and SICZ, which extends southeastward from the African Continent to the South Indian Ocean, are reasonably reproduced by the model. The confluence and convergence of the South Indian Ocean monsoon westerly with the easterly trade wind around the South Indian Ocean subtropical anticyclone are the essential condition for the formation of SICZ. Likewise, the South American monsoon circulation and SACZ, which extends southeastward from the southern part of Brazil to the South Atlantic, are also reasonably reproduced. The confluence and convergence of the South American monsoon westerly with the easterly trade wind around the South Atlantic subtropical anticyclone are the essential condition for the formation of SICZ. Many common features are found in the simulated MBFZ, SICZ and SACZ, in regard to the frontal structure and the associated synoptic- and meso- -scale disturbances, and the relation to the respective subtropical anticyclone and the monsoon circulation. However important difference is seen between their geographical environments. The cold south Atlantic in the pole-ward side of the SACZ, the cold south Indian Ocean in the pole-ward side of the SICZ provides the significant baroclinicity for SACZ and SICZ, while the existence of warm land mass to the pole-ward side of the MBFZ brings on the weak baroclinicity of the MBFZ.

Keywords: monsoon, subtropical convergence zone, agcm simulation

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JMS011 **Poster presentation** **1080**

Impact of Enso and Indian ocean dipole on the australian summer monsoon

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It is known that eastern Australia has a very robust ENSO signal in the October November December (OND) season. On the other hand, OND season is period of most strong anomalies for Indian Ocean Dipole events. The influence of El Nino for Australian summer monsoon often had showed as hot and dry conditions in the first part of the season. The influences of the ENSO and Indian Ocean Dipole (IOD) events on the Australian summer monsoon rainfall were stadied based on analyse for years: with pure El Nino (2002), with El Nino and positive events of IOD (1997 and 2006), with La Nina (2000). The mean month NCAR/NCEP reanalyses data were used for study. The anomalies of rainfall, OLR, sea level pressure, surface zonal wind, velocity potential were analysed for austral spring and summer seasons in Indian-Pacific tropical region. The analyses demonstrates that patterns of anomalies in 2000 (with La Nina) were opposite patterns of anomalies in 2002 (with El Nino). Anomalies in 2006 (with El Nino and IOD) were more intensive than in 2002 (with El Nino). In spring and summer seasons 2002 and 2006 years the results show strong rainfall deficit, surface anticyclonic anomalies in Australia region and strong eastern zonal wind anomalies along South Indonezia, North and East-North Australia. In 2006 strong surface anticyclonic circulation anomalies were observed as over Australia as over South-East Indain ocean and were connected with strong eastern zonal wind anomalies in equatorial Indian (IOD). During an El Nino event the Walker circulation over tropical Indian-Pacific region is modulated: a low-level anomalous divergence center over western Pacific and convergence zone over central and eastern Pacific are induced. When strong positive IOD event occurs with El Nino the strong anomalous divergence zone is introduced in the eastern tropical Indian ocean during austral spring season. The analyses of anomalies demonstrates that the positive IOD events reduced the impact of El Nino on the Australian summer rainfall in 1997. The anomalous divergent flow provided the strong west flow of moisture air to North Australia in summer 1997/1998. In December 2006 unlike December 1997 were observed a strong intensification of east zonal wind anomalies along South Indonezia, North and East-North Australia and strong weakening of west zonal wind anomalies in equatorial central Pacific ocean.

Keywords: enso, indian ocean dipole, australian summer monsoon

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JMS011 **Poster presentation** **1081**

Seasonal and interannual variation of gravity waves in Equatorial Africa

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The present study focuses on the variability of convective gravity waves in equatorial Africa area in the lower stratosphere. Some climatologies of gravity-waves have been produced especially in for USA and Australia. Little is known about the variability of gravity wave activity in equatorial Africa and about sources in relation with monsoon in particular. Gravity waves are analyzed from daily data of meteorological radiosondes launched between 18 N and 05N archived on the site of Wyoming University from January 1973. This data set will be soon completed with high resolution radiosonde and radar data provided by AMMA (African Monsoon Multidisciplinary Analysis) campaign. The seasonal and interannual variations of some gravity wave parameters for different observation sites are investigated. 1. J2. Monsoon systems3. gravity waves, stratosphere, equatorial africa, monsoon4.

Keywords: gravity waves, stratosphere, equatorial africa monsoon

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JMS011 **Poster presentation** **1082**

Sensitivity of the east asian summer monsoon to the cumulus parameterization scheme in a regional climate model

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The cumulus parameterization scheme (CPS) representing the subgrid-scale parameterized convection has been considered one of the most challenging and uncertain aspects of the numerical modeling of the atmosphere. It is also realized that the subgrid-scale deep convection embedded within a certain synoptic environment accompanying the Changma front plays an important role in forming monsoonal precipitation over East Asia in summer. Despite the numerous precedent studies on the CPS intercomparison in numerical weather prediction and climate models, it has rarely been investigated for the multi-years climatology more than a decade over the East Asian summer monsoon (EASM), which is one of the most complicated and energetic monsoon systems in the world. The purpose of this study is to examine the sensitivity of the simulated regional climate circulation and precipitation associated with the EASM to the three CPSs, i.e., the Simplified Arakawa-Schubert (SAS), the NCAR Community Climate Model version 3 (CCM), and the new Kain-Fritsch (KF) schemes, using a regional climate model. These three CPSs are selected because of the widespread use in climate and mesoscale modeling studies, and representativeness of different closure assumptions and scale consideration. The NCEP regional spectral model (RSM) is used for three-month (June-July-August; JJA) long simulations for 10 years from 1991 to 2000, and it is forced by the NCEP-DOE reanalysis dataset produced by the NCEP operational global forecast model in which the SAS scheme is adapted as the CPS. In terms of the 10 years climatology, the JJA precipitation simulated by the SAS and KF experiments show similar spatial pattern to each other, which produce the reasonable EASM rain band compared to the observed precipitation except for the wet bias over the northern and northeastern China. However, these two CPSs have significantly different characteristics in the partitioning total precipitation into the convective and grid-resolvable scale precipitation. Meanwhile, the total precipitation simulated by the CCM experiments is confined in southern boundary of the model domain close to the tropical convective regimes, which is well known as a typical characteristic of the CCM scheme. Despite the significant differences in precipitation amounts among three experiments in terms of long-term climatology, interannual variations of the domain-averaged amounts during the 10 years are similar to each other. This similarity attributes to the lower-atmospheric moisture transport caused by the EASM circulation which can be commonly captured by all CPSs. Further detail analyses to understand the role of the CPS and identify similarities and differences among these three CPSs in the EASM simulation will be given in the presentation using several statistical methods such as principal component analyses and spectral filtering.

Keywords: east asian summer monsoon, cumulus parameterization, regional climate modeling

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JMS011 **Poster presentation** **1083**

Simulated interannual variation in summertime atmospheric circulation

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The reproducibility of the interannual variability of the summertime East Asian circulation is examined using an AGCM. An ensemble experiment is conducted using observed SST and seaice concentration as a lower boundary condition and each run is integrated for 20 years. The spatial pattern associated with the first principal mode of observation of geopotential height at 500 hPa is characterized by meridional wavy pattern extending over eastern Siberia, vicinity of and subtropical western Pacific. The principal component (PC) time series of the leading mode is represented well by a high resolution version of the AGCM with horizontal resolution T106 and with 56 vertical levels (T106L56), while with a lower resolution version, T42 and 20 vertical levels, the reproducibility is considerably degraded. The reproducibility by AGCM suggests the importance of SST as a boundary condition. However, the simulated interannual variations show alternating appearance of two distinct circulation regimes, cold summer regime and hot summer regime, exhibiting interesting bimodality in probability density distribution in PC phase space. This implies that the systems response to the continuously varying boundary condition includes nonlinearity. The nature of this nonlinearity is suggested to be wave breaking in the westerly region of the high latitude that requires high resolution for the reproduction. Using the T106L56 model, another ensemble experiment was carried out with doubled CO2 condition. The climate change appears as an increase in residence frequency of cold summer regime of the principal patterns of the present-day climate.

Keywords: east asian climate, agcm, global warming

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JMS011 **Poster presentation** **1084**

Roles of the Brazilian Highland in the formation of SACZ Part I: Numerical experiments using RAMS

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The South Atlantic convergence zone (SACZ) is a significant rain-band which develops over South America and the South Atlantic in austral summer. SACZ is one of predominant components of South American monsoon system (Zhou and Lau 1998). SACZ shifts north and south, but in climatological mean, SACZ extends passing through the Brazilian highland (BH). Numerical experiments were performed using theRegional Atmospheric Modeling System (RAMS) to clarify the roles of the BH in the formation of SACZ. Calculation domain covers South America and surrounding oceans with 50 km grid interval and vertically 30 layers. Boundary region of the domain is nudged toward 6 hourly NCEP-NCAR reanalysis. Sensitivity study on the height of the BH was done for one month of January 1985, when SACZ was significant, for four cases with different height factors over the BH; 0%, 50 %, 100% (control), and 200%. SACZ in the model appeared more strongly as increasing the height factor. When the BH was low, precipitation over the BH was weak and low-level trade wind over the Atlantic flew toward the Andes passing through BH. Moisture convergence over the BH and SACZ over the Atlantic were weak. When the BH was tall, moisture convergence and precipitation over the BH increased. A low-level cyclonic circulation appeared over the BH. Three streams, i.e., the easterly trade, north westerly of low-level jet from Andes and southwesterly along the western edge of cyclonic circulation, converged and flew into the SACZ over the Atlantic. It suggests that precipitation induced by the BH plays an important role in forming SACZ.

Keywords: sacz, subtropical convergence zone, south american monsoon

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JMS011 **Poster presentation** **1085**

SST - Convection relationship associated with divergence over Asian Summer Monsoon Region

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Coupled processes between the Indian and west Pacific Oceans and atmosphere govern the spatial structure of the intra-seasonal state of convection in the summer monsoon region. At the same time, large scale atmospheric circulation with its upper level divergence and low level convergence have significant influence on the SST - convection structure. In this paper, an attempt is made to establish the link between upper level (200 hPa) divergence and SST-convection over the oceanic regions during monsoon. Analysis was carried out for the period 19792002 using NCEP SST, ECMWF (ERA-40) 200 hPa divergence and NOAA Outgoing Long wave Radiation (OLR) for establishing relationship between these three parameters. From 1998 onwards, high resolution (25 km) SST data is available globally between latitudes 40S and 40N from TRMM Microwave Imager (TMI). The observed SST-convection relationship provides the vital role played by the SST in triggering convection. However, convection is not initiated at all regions of high SST over the Bay of Bengal (BOB). The SST-convection relationship is further analysed to understand how deep convection varies with SST change in SST and with constant SST. It is found that convection is triggered by SST gradient rather than simply high values of SST in the tropics. Further, the frequency of occurrence of convection is more when the gradient is more than 0.75C over 5latitude belt in the BOB. Similarly, a region of small gradient is associated with feeble or suppressed convection. Further analysis was made to understand the role played by 200 hPa divergence over BOB and west Pacific Ocean in modulating SST-convection relationship. 200 hPa divergence over BOB is positive and favourable for convection. Negative divergence is observed over the west Pacific. On the basis of this, we classified the SST-convection field with 3 classes of divergence averaged over5N to 25N and 80E to 100E as divergence >5e-6, 2.5e-6 to 5e-6 and <2.5e-6. The linear correlation coefficient analysis of these three classes of SST-convection series gives -0.68, -0.45 and 0.41 respectively. When the BOB divergence is positive, the west Pacific divergence is negative or with suppressed convective activity. The Empirical orthogonal function analysis of seasonal OLR, SST and divergence also confirms the possibility of large-scale upper level divergent wind as an additional thrust for the deep convection over the monsoon region.

Keywords: sst convection, upperlevel divergence, monsoon

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JMS011 **Poster presentation** **1086**

Chinese AIPO Project and AMY08

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Guoxiong Wu

This presentation will introduce the National Basic Research Program of China entitled Ocean-Atmosphere Interaction over the Joining Area of Asia and Indian-Pacific Ocean (AIPO) and Its Impact on the Short-Term Climate Variation in China and the initiative of Asian Monsoon Year-2008 (AMY08), especially, focuses on the key scientific issues, subprojects, observation experiments and some latest progresses of the AIPO, and the history, motivation, objectives, key science questions, observation experiment implement plan and organization structure of AMY08.

Keywords: aipo, asianmonsoonyear, ocean atmosphereinteraction

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JMS011 **Poster presentation** **1087**

Weakening trend and interannual variability of Indian summer monsoon

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Indian summer monsoon has been associated with large fluctuations in different time scales. The magnitude of the fluctuation varies with locations. A knowledge of inter annual summer monsoon rainfall variability is essential for planning especially for the agricultural production and the Indian economy. The analysis was made using daily rainfall data (AIDMR), which was procured from the India Meteorological Department (IMD). Southwest monsoon seasonal rainfall was derived from the AIDMR from 1901 to 2002. In addition, the zonal wind at 850 hPa from the NCEP/NCAR was used to understand its role for bringing good and bad monsoon years over . This data set has a temporal resolution of a day and spatial resolution of 2.5 X 2.5 latitude-longitude grid. Area averaged zonal wind at 850 hPa over 70E-80E & 10N-20N is considered for the study. Here, good monsoon years are identified when the annual rainfall of the year is more than 10 % of the normal rainfall (103 cm) and bad monsoon years when it is less than 10 % of the normal. Different types of variability of ISMR in different time scales were also found using wavelet analysis. From the long term trend analysis, we noticed that ISMR has two phases, based on the nature of the slope of the trend. It is found that in the first phase, the rainfall increases from year to year other than the biennial oscillation. This phase lies from 1901 to 1964. The wind characteristics also show similar pattern. The second phase starts from 1965 to 2002. In this phase, the rainfall trend is exactly opposite. The slopes of the trend in the first phase and second phase are 2 and -6.5 respectively. This indicates that ISMR shows a decadal weakening trend in the second phase. This weakening trend may continue for another few years. The variability of the ISMR and wind show almost similar behavior in the decadal and seasonal scales. Another important feature is a 5 decadal variability embedded in the long term variability of monsoon rainfall and this mode of variability causes to the phase change of the ISMR. In addition to the decadal variability, an 11 year mode and biennial mode were also present. It is found that in the second phase, the zonal wind at 850 hPa and AIDMR are almost in the same phase. The percentage of bad monsoon years is high in the second phase (32 %) in comparison with the first phase (15 %) and vice versa in the case of good monsoon years. The linear correlation coefficient between zonal wind at 850 hPa and AIDMR for good monsoon years is 0.77 and that for bad monsoon is 0.91. In both the cases, the value of correlation coefficient is confident. The high correlation coefficient values indicate strong influence of zonal wind at 850 hPa for bringing the monsoonal rainfall over .

Keywords: monsoonvariability, interannualvariability, monsoonrainfalltrend

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JMS011 **Poster presentation** **1088**

The combined role of ENSO and Indian Ocean dipole episodes on the onset of the South American Monsoon System

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Tercio Ambrizzi

The combined role of the El Nio-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) on the onset of the South American Monsoon System will be analyzed here. From nine positive IOD events (characterized by positive sea surface temperature anomalies in the western Indian Ocean and negative over the eastern side of the basin) selected through the application of a multivariate analysis for the period 1950-2003, it was found that six occurred during El Nio events, two in neutral years and none of them in La Nia episodes. On the other hand, from the eleven negative IOD episodes selected, three were observed in El Nio events, two in neutral years and four during La Nia episodes. These five classes were studied through composites of anomalies elaborated for the austral spring.In the neutral episode composites, even without the co-occurrence of ENSO, both IOD phases presented distinct impacts on the South American precipitation. Enhanced precipitation over southeastern South America and drought conditions over the tropical Brazil were observed during the neutral ENSO/positive IOD events, associated with an anomalous anticyclonic circulation over the Central Brazil that enhanced the moisture transport from the Amazon Basin towards La Plata basin. During the neutral ENSO/ negative IOD episodes, positive precipitation anomalies occurred over the La Plata basin and western Brazil, associated with an anomalous anticiclonic circulation over southwestern South Atlantic that enhanced the anomalous moisture flux divergence over northeastern Brazil and convergence over southern Brazil.Comparing the El Nio impacts related to both IOD phases, it seems that the co-occurrence of positive IOD events enhances the configuration of the typical El Nio precipitation anomalies described in the literature, characterized by positive values in the southern Brazil and negative in the north and northeast Brazil which is associated to an upper level anomalous anticyclonic circulation over southeastern Brazil that enhanced the moisture transport from Amazon Basin towards subtropics. The El Nio/negative IOD episodes present weaker negative anomalies in the tropics and the positive displaced towards Paraguay.It is also interesting to note that enhanced precipitation in the tropical Brazil and drought in the southern Brazil occurred in the La Nia/negative IOD events. This anomalous pattern is different from the impacts observed during the El Nio and neutral years for the negative IOD phase. These results suggest that the role of ENSO on the South American precipitation prevails during the occurrence of the negative IOD phase. However, the impacts of the positive IOD events are quite independent of the ENSO phase.In order to explain the dynamical aspects of the interaction between the ENSO and IOD episodes, numerical experiments with a general circulation model are being carried out and they will be presented elsewhere.

Keywords: enso, iod, precipitation

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JMS011 **Poster presentation** **1089**

Roles of the Brazilian Highland in the formation of SACZ Part II: A statistical study using long term observational data

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South Atlantic convergence zone (SACZ) is one of predominant components of South American monsoon system (Zhou and Lau 1998). In companion study using regional climate model (Part I), we suggested that low-level circulation induced by Brazilian Highland (BH) plays an important role in forming SACZ. To examine the hypothesis, statistical relationship in intraseasonal time-scale variations between precipitation and height field were investigated for austral summers (DJF) in 27 years between January 1979 and February 2005. 5-day averaged CPC Merged analysis of Precipitation (CMAP) and 5-day averaged NCEP/NCAR reanalysis data were utilized to examine intraseasonal time-scale variation. Reference area of 7.5 x 7.5 (lat. x lon.) degrees was moved along SW-NE line passing through the BH. Correlation in precipitation between the reference area and the other area was investigated. When we put the reference area over the BH, a significant zone of positive correlation in precipitation, which corresponds to SACZ, extended southeastward over the South Atlantic. Although the southeastward extension was also observed when the reference area was shifted along the SW-NE line along the coast, extension was most significant when the reference area was over the BH. This means that SACZ over the Atlantic is most activated when precipitation over the BH is strong. Correlation between 850hPa height in the reference area and precipitation was also examined. When the reference area was located over the BH, negative correlation between height and precipitation was found along SACZ including over the BH. This is consistent to the suggestion shown in Part I that precipitation over the highland intensifies a low-level cyclonic circulation, along with low-level convergence around the BH and along SACZ.

Keywords: sacz, subtropical convergence zone, south american monsoon

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JMS011 **Poster presentation** **1090**

Southwest and northeast monsoon onsets over Malaysia and some salient monsoonal features

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See Hai Ooi

Malaysia, being surrounded by the Andaman Sea to the west, the South China Sea, the Sulu Sea and Celebes Sea to the east, is subjected strongly to the pulsation and contraction of easterlies and westerlies in consonance with the temporal influence and variation of large-scale differential land-sea heating or the monsoons. The onset of monsoons in the region is best determined using 850 hPa winds. The mean onset dates of southwest and northeast monsoons are 22 April and 25 October respectively. The southwest monsoon could set in as early as 1 April and as late as 15 May while the onset of northeast monsoon could fall as early as 5 October and as late as 15 November. In an El Nino year, it appears that northeast monsoon sets in earlier and southwest monsoon sets in later. Also, in the El Nino phase, significant reduction of convection occur in most part of East Malaysia during the southwest monsoon and eastern part of East Malaysia during the late northeast monsoon. This is consistent with the significant negative sea surface temperature anomalies during the southwest monsoon and positive anomalies during the late northeast monsoon particularly in the coastal waters of Sabah. Weakening of the Hadley and Walker circulations are only prominent during the northeast monsoon under the influence of El Nino and the Pacific Walker circulation is also noted to shift about 20 degreeeastwards. The southwest monsoon break period is a significant intraseasonal monsoon variability over Malaysia.

Keywords: monsoon, onsets, variabilities

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JMS011 **Poster presentation** **1091**

The North American monsoon in IPCC AR4 models

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We evaluate the North American monsoon and its teleconnection patterns in simulations performed by 17 atmosphere-ocean general circulation models that have provided output in support of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). Observational studies have shown a dynamical response to heating from organized deep convection in the North American monsoon that induces a continental scale teleconnection pattern. The teleconnection causes precipitation over the monsoon core region over northwest Mexico to be out-of-phase with precipitation over the central U.S. and in-phase with precipitation over the eastern coast of North America. Results were analyzed both for current climate (1970-1999) and for a future-climate scenario with increased concentrations of greenhouse gases (the SRES A1B scenario, nominally 2070-2099). Simulated precipitation over northwestern Mexico was found to be broadly consistent with the observed monsoon, but the continental-scale teleconnections were mostly weaker than observed. Some models produced a realistic teleconnection pattern, some produced overly strong and extensive teleconnections, and others produced only a weak teleconnection or even a teleconnection of opposite sign to that observed. SRES A1B results for 2070-2099 indicated little change in the continental-scale teleconnection pattern, but the large inter-model variability implies little confidence in this result. Unexpectedly, we found no relationship between the ability of a model to accurately depict precipitation in the monsoon core and its ability to depict the teleconnection pattern. The lack of such a relationship implies that current state-of-the-art AOGCMs do not realistically represent the dynamical response to latent heat release by convection in the monsoon core. We suggest that the ability of a model to reproduce the precipitation signal in the monsoon core is a necessary but not sufficient condition for reproducing the continental-scale circulation patterns associated with the NAMS.

Keywords: monsoons, climate, ipcc

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JMS011 **Poster presentation** **1092**

Characteristics of Monsoon Surges associated with the Indian summer monsoon

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Indian summer monsoon is associated with organized convection as part of ITCZ formed due to differential heating. The onset, active and break epochs of Indian summer monsoon are important since the economy depends on monsoon rainfall. Here, an attempt is made to understand the characteristics of monsoon surges formed over the Indian subcontinent i.e., onset and active cycles of monsoon system. The objective of the study is to bring out the characteristics of the surges and is carried out using NOAA Outgoing Long Wave Radiation (OLR), wind and vorticity at 850 hPa, vertical velocity at 500 hPa, precipitable water available from NCEP/NCAR reanalysis and SST data set available from TMI on a daily basis from 1 April to 31 October for many monsoon seasons. The date of monsoon onset is taken from the Indian Daily Weather Report of India Meteorological Department. The area average (70 E - 80 E, 0 - 10 N) OLR daily values were examined for the study period to find the dates of evolution of the organized convection. It is found that about six weeks prior to the normal monsoon onset (NMO), an organized convective cloud band is formed over the low latitudes of North Indian Ocean and is referred to as Bogus Monsoon Onset (BMO) and is also referred to as pre-monsoon rain peak. This surge is feeble in nature. Similarly, about six weeks after the monsoon onset (NMO) another surge is formed over east equatorial Indian Ocean and is referred to as Second Monsoon Onset (SMO). These surges move to the north. The intensity of the cloud band associated with the monsoon surge is maximum for the normal onset. Similarly, another one or two surges form in the equatorial Indian Ocean and move to the north. But they dissipate before reaching Himalayan region. Different from other surges, the pre-monsoon surge is feeble in nature and does not move northward beyond 15 N. The monsoon surges once reached over the Rajasthan region survives for a short period due to non availability of moisture. It is found that when the normal onset surge reaches foot hill of Himalaya, another cloud band forms over the equatorial Indian Ocean . This intensifies further and moves to north as next surge. As it passes Indian subcontinent, the organized convection over the Himalayan region dissipates. These organized convections are considered to be monsoon surges activated over the south Arabian Sea or equatorial Indian Ocean when the conditions are favorable and can be treated as part of intra seasonal oscillation. Further details about the characteristics are incorporated in the paper.

Keywords: monsoon surge, bogus onset, olr

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JMS011 **Poster presentation** **1093**

Monsoon variability predictability and possible modulations by anthropogenic aerosols

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Meteorology

The paper presents the present status on the observed variability of Indian Summer Monsoon in the last 100 years on Intra-Seasonal and Inter-annual scales. It also discuss the simulations of monsoon variability in the recent climate change simulations and discusses the large scatter noted in different atmospheric stand alone and coupled ocean atmospheric models. The simulations made by the introduction of aerosols on monsoon variability by different models are also presented. Data on the aerosol monsoon interactions to the recent droughts of 2002 and 2004 and the near normal monsoon 2006 are discussed. It is suggested that the mid-season oscillation of monsoon in monsoon trough region are controlled by the position of monsoon trough and the pathway followed by monsoon wind in approaching monsoon trough. In the case of drought monsoon seasons, the air flow is from North West and the desert air mass reaching Gangetic plain could impact on the monsoon to sustain the drought.

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JMS011 **Poster presentation** **1094**

Asymmetry of the Tripole Rainfall Pattern during East Asian Summer

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Shih-Ming Lin

This study investigates the tripole rainfall pattern in East Asia during the northern summer. The tripole pattern is characterized by a zonally elongated and meridionally banded structure with signs changing alternatively from 20N to 50N along the East Asian coast. The positive (negative) phase of the pattern is characterized by more (less) rainfall in central eastern China, Japan, and South Korea, and less (more) rainfall in northern and southern China. Asymmetry between the positive and negative phases is one of the key findings of this study. The tripole pattern is closely associated with two wave-like patterns, namely, the Pacific-Japan pattern and the Silk Road pattern. The former, which emanates from the tropical Western Pacific to extra-tropical East Asia, is more evident in the positive phase, while the latter, emanating across the Eurasian continent, is more evident in the negative phase. The positive phase appears to have a stronger tropical connection, while the negative phase has a stronger extra-tropical connection. The positive and negative phases are associated with the positive and negative SSTA in the equatorial Eastern Pacific, respectively. It is suggested that in the positive phase the zonally oriented overturning circulation driven by the positive SSTA in the equatorial Eastern Pacific induces heating anomalies in the tropical Western Pacific, which in turn triggers a wave-like pattern emanating northward toward extra-tropical East Asia. This indirect SSTA effect is not evident in the negative phase, which is predominantly affected by the extratropical Eurasian wave-like perturbations. On the other hand, anomalous heating over the eastern Tibetan Plateau seems to induce the eastward-propagating wave-like structure in both phases. It is suggested that the tripole pattern is a result of the amplification of an intrinsic dynamic mode that can be triggered by various factors despite of their different origins.

Keywords: asymmetry, tripole rainfall pattern, east asian summer

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JMS011 **Poster presentation** **1095**

A statistical study on rain characteristics of tropical cyclones using TRMM satellite data

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Yukari N. Takayabu

In this study, we analyze precipitation data obtained from the Tropical Rainfall Measuring Mission (TRMM) satellite to quantify 3-dimensional rain characteristics of tropical cyclones (TCs) statistically. PR2A25 ver.5 data from the Tropical Cyclones Database are used for the analysis of TCs from December 1997 to December 2003. The database consists of 562 TCs or 3706 snapshots, including tropical depressions. TCs are divided into 4 intensity classes and 3 stages such as developing, mature, and decaying stage referring to the Best Track Data by JTWC, NHC, and CPHC. Full-orbit PR2A25 and LIS data are also utilized. First, the rain characteristics of TCs are compared with those of equatorial (10N-10S) mean. Both TCs and the equatorial mean consist of convective area and large stratiform area. Stronger rain is observed in TCs both for convective and stratiform rain. At the same time, stratiform rain substantially contributes to total amount of rainfall. The stratiform rain ratio (SRR) of TCs is 54% in average, which is larger than the equatorial oceanic mean (44%). Secondly, we analyze radial rain characteristics of TCs. Inner core is defined with small SRR, which is found inside of ~60 km radius. There the lightning flash rate is large, which indicates the vigor of convective activity. Contrastingly in the rainband from 60 km to 500 km radius, SRR is always greater than that of the equatorial oceanic mean, and rain-yield per flash is relatively large, which means it rains efficiently although convective activity is moderate. Finally, we estimate the rainfall contribution of TCs within 500 km radius to the total annual rainfall in the entire TRMM observational region (35N-35S). We utilize the mean rain rates derived by PR2A25 and the mean lifetime of each stage and TC numbers in each class, derived using the Best Track Data. As a result, annual mean rainfall of 2.71023 mm3 yr-1 and TC rainfall of 8.61021 mm3 yr-1 are obtained, so that the contribution of 500km-TC rainfall in the TRMM region is estimated as about 3.2%.

Keywords: tropical cyclone, precipitaion, trmm

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JMS011 **Poster presentation** **1096**

Numerical study of the influence of the landuse change on the monsoon rainfall over Indochina using a cloud-resolving regional climate model

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Takao Yoshikane, Tetsuzo Yasunari

Influence of the landuse change on monsoon rainfall over indochina was investigeted using a cloud resolving regional climate model. It was reported that the influence of the deforestation on land process is serious problem in the Thailand. For example, Kanae et al. (2001) suggested that the long-term trend of the decrease in rainfall is caused by the deforestation in the past 50 years using the regional model with 60 km grid spacing. However, the grid spacing with 60 km of the model is not enough to reproduce the dirnal cycle of rainfall, which is induced by the local topography and indispensable to form the climatic precipitation over Indochina. Therefore, we conducted the cloud resolving simulation with 5 km grid spacing to represent the meso-scale rainfall system in the diural precipitation.Weather Research and Forecasting (WRF) Model version 2.1.2 was used. Two types of experiments, control (CTL) and green vegetation (GVE) runs, were conducted. Initial and boundary conditions were given by NCEP/NCAR Reanalysis. Calculation periods of the both runs are from 1st to 30th September 1998 and 1999. The United States Geological Survey (USGS) landuse category was used on the CTL. On the GVE, the landuse types of artificial developments (such as irrigated cropland) were replaced by savanna, which was assumed as 1950's vegetation.Rainfall distribution of CTL run was almost well simulated over northern and central Indochina, whereas, poor over southern Indochina, compared with observations. The differences in rainfall between the CTL and GVE runs shows that CTL run is more rainfall (about 10 mm/month) over the central Indochina. The magnitude of the change between the two is much smaller than that of interannual variations. The difference was likely to be responsible for the enhancement thermally induced local scale circulations. The detailed mechanisms behind the slight increase of rainfall due to the artificial landuse changes would be discussed.

Keywords: monsoon, landuse, cloud resolving

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JMS011 **Poster presentation** **1097**

Downscaled current climate of the asian monsoon using a regional climate model

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The regional climate modeling is a valuable dynamical downscaling tool for providing regional detail information in order to assess seasonal climate prediction, climate change impacts, and consequently to improve our understanding for the Earths climate system. Multi-year to multi-decadal simulations should be required to obtain meaningful climatology and its variability, and to identify and reduce significant systematic errors through sensitivity experiments. Up to date, however, only a few studies reported multi-year or interdecadal simulations for the Asian region forced by perfect boundary condition and Atmospheric General Circulation Model (AGCM) forcing, because the Asian monsoon is the most huge, energetic, and complicated monsoon system in the world. Furthermore, most previous studies for the Asian region focus on summer season. The purpose of this study is to evaluate the National Centers for Environmental Predictions (NCEP) regional spectral model (RSM) for the 10-years-long simulation forced by perfect boundary condition and AGCM-simulated large-scale conditions for climate prediction over Asia , which includes both the Indian and East Asian regions. To this end, two experiments forced by the NCEP-Department of Energy (DOE) reanalysis (RA2) and the fifth generation version of the ECMWF Hamburg Atmospheric general circulation Model (ECHAM5) are conducted with an approximately 60 km horizontal resolution over Asia. The simulation period covers from 1 July 1988 to 31 December 1998, and the first 6 months are ignored as a spin-up time. The analysis of the model results focuses on both the summer and winter seasons. Not only the seasonal mean climatology but also the interannual and intraseasonal variability of the Asian monsoon circulations are investigated. In terms of domain average, preliminarily, the 10-year-long simulated climatology forced by RA2 boundary simulation shows warm and wet biases in summer and slight cold bias in winter. The precipitation in winter is successfully reproduced. For the Asian Summer Monsoon (ASM) region, the model underestimates precipitation most areas over ocean and southeastern , which is a systematic bias of the RSM. The underestimated precipitation also appears in the Indian Summer Monsoon (ISM) region, i.e., near the Bay of Bengal. Further detail analysis of RA2 boundary simulation and their variability as well as downscaled ECHAM5 results will be given at the conference.

Keywords: east asian summer monsoon, regional climate model, interannual variability

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JMS011 **Poster presentation** **1098**

Impact of land cover/land use changes since 1700 on changes in asian monsoon system

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The impacts of land cover/use changes in Asia and Europe since 1700s on the Asian monsoon system and climate in the northern hemisphere both in summer and winter have been examined using the atmospheric GCM. The data of land cover/use change is adopted from Hirabayashi et al.(2005). The results suggest that the regional removal of forests in south Asia, southeast Asia and east Asia during 1700s to the present (1990s) might have weakened Indian summer monsoon whereas the overall Asian summer monsoon circulation may have been intensified due to less roughness condition of the deforested areas. Another interesting feature in this experiment may be relatively strong impacts of deforestation and expansion of arable land in western and eastern Europe since 1850 to present on circulation changes overEurasia particularly in winter, which may be partly responsible for change of winter monsoon in east Asia. Details of the experimental results will be reported in the session.

Keywords: land cover use change, asian monsoon system, land surface process

Intercomparison of the 22-year east asian summer monsoon circulation simulated by the RegCM3 and RSM

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E-Hyung Park, Hyun-Suk Kang, Song-You Hong

East Asian summer monsoon (EASM) is one of the most huge, energetic, and complicated monsoon systems in the world. Furthermore, several countries in East Asia usually suffer from severe floods and/or droughts in summer due to the interannual and intraseasonal variability of the EASM, which is still difficult to predict accurately. In this context, regional climate model (RCM) is a valuable tool in understanding the nature of the EASMs behavior as well as in reproducing regional details information driven by observed and/or simulated large-scale forcings. During the last decade, several intercomparison projects of the regional climate model (RCM) have been conducted in order to assess performance and uncertainties of RCMs for a few continental scale regions such as North America, Europe, and Asia . Although the Regional Climate Model Intercomparison Project (RMIP) for Asia has investigated ensemble averages of the regional climate over the entire Asian continent, it is hard to identify strength/weakness in reproducing EASM regional climate among several participating RCMs due to not only the somewhat large domain size but also the similarities in model prototype, that is, the MM5. In this study, we focus on the EASM region only using two representative regional climate models, i.e., the National Centers for Environmental Prediction (NCEP) regional spectral model (RSM) and Regional Climate Model version 3 (RegCM3); the former is the spectral model, while the latter is finite difference grid model based on the MM5. Three-month-long summer season (June-July-August) simulations for 22 years from 1982 to 2003 are conducted. Downscaling ability for the EASM climate and its variability between these two RCMs will be given in the conference, particularly in terms of interannual, intraseasonal, and diurnal variations during 22 years.

Keywords: east asian summer monsoon, intercomparison, regional climate

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JMS011 **Poster presentation** **1100**

The change of the onset and retreat of rainy season over Thailand region under global warming scenario

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Shinjiro Kanae, Taikan Oki

The changes in onset and retreat of the rainy season over Thailand was investigated using the daily rainfall data produced by a high resolution version of the CCSR/NIES/FRCGC model (1901-2100), the NCEP/NCAR reanalysis (1979-2006), and the routine observation over Thailand (1951-2000), and the daily wind data utilized by a high resolution version of the CCSR/NIES/FRCGC model (1901-2100). After spin-up with year 1900 climate conditions, the model was integrated to year 2100 with historical and future scenario (SRES A1B defined by IPCC2000 report) forcing. We use simulated data for periods 1971-2000 and 2071-2100 to describe the present-day and future monsoon activity. The average date of monsoon onset and retreat is almost same between the present-day and future. The some aspects are found in regional difference. In , monsoon onset in future has a rather variance in year to year than that in present-day. It is suggested that the monsoon variability over is affected by global warming.

Keywords: global warming, interannual variation

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JMS011 **Poster presentation** **1101**

The impact of the global warming climate on the distributions and characteristics of cloud-systems during the Baiu/Meiyu season around the East Asia by a cloud-resolving non-hydrostatic regional model.

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Forecast Research AESTOMRI

Yasutaka Wakazuki, Chiashi Muroi, Akihiro Hashimoto, Teruyuki Kato, Kazuo Kurihara, Akira Noda, Masanori Yoshizaki, Kazuaki Yasunaga, Masaomi Nakamura

The impact of the global warming climate on rainfall and cloud-systems has been one of the greatest interests in the global climate, the regional climate and cloud physics. Therefore we have carried out numerical simulations with the non-hydrostatic regional climate model that has been developed on the basis of Japan Meteorological Agency Non-Hydrostatic Model in order to reveal the change/modification of rainfall and cloud-systems around the East Asia during the Baiu/Meiyu season under the global warming climate as well as those in present climate. A semi-cloud resolving model with a horizontal grid of 5 km optimized for the Earth Simulator is nested in Global Climate Model (GCM), which has a horizontal grid of 20 km, during 21st May to 29th July for every 10 year. First, changes in the lifetimes and locations of the Baiu/Meiyu fronts, rainfall amounts, rainfall distributions and rainfall intensities around the East Asia are studied in detail. Under the global warming climate, the Baiu/Meiyu season continues to August with the stagnation of Baiu/Meiyu front around 30-40 N. Rainfall amount over western Japan increases especially in early July, and the increase ratios are notable with the higher rainfall intensities. Second, the cloud-systems are classified into 5 categories, Deep Cloud system (DC), Deep Stratiform system (DS), Low cloud-top Convective system (LC), Low cloud-top Stratiform system (LS) and other system, by using 2 indices, the top heights of the mixing ratio of cloud water and intensities of updrafts ofeach system. The "Low cloud-top system" indicates the cloud-system whose top locates below 0 K level. The horizontal scales, frequencies, ratios to the total population, precipitation efficiencies and updraft structures of the cloud systems in each category are studied in various areas over the East Asia in both the present and global warming climates. One of the most remarkable changes from the present climate to the global warming climate is the increase of total population of cloud-systems from the East China Sea to western Japan. Low cloud-top systems are seen almost all over the East China Sea and it is notable that LCs (i.e. Low cloud-top "convective" systems) which have relatively intense updrafts in the lower level, appear over the southern part of the East China Sea in the global climate. Further characteristics in the distributions and the structures of cloud systems, as well asthe stratification conditionson each category will be presented.

Keywords: cloud system, baiu season, global warming

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JMS011 **Poster presentation** **1102**

Dynamic and thermodynamic effects on the Asian summer monsoon under doubled atmospheric CO2

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Floods and droughts associated with the Asian monsoon directly impact billions of people and the economies of many Asian countries. The response of the Asian summer monsoon to global warming is of critical concern to Asias large population. However, despite numerous studies, the response remains unclear. This study used results from a high-resolution atmospheric global climate model (AGCM) to investigate how dynamic and thermodynamic changes influence extreme precipitation during the Asian summer monsoon. Results from time-slice ensemble experiments using the T106 AGCM revealed changes in the South Asian summer monsoon resulting from climate change. Model results under global warming conditions suggested more warming over land than over the ocean, a northward shift of lower tropospheric monsoon circulation, and an increase in mean precipitation during the Asian summer monsoon. The number of extreme daily precipitation events increased significantly. Increases in mean and extreme precipitation were attributed to greater atmospheric moisture content (a thermodynamic change). In contrast, dynamic changes limited the intensification of mean precipitation. Enhanced extreme precipitation over land in South Asia arose from dynamic changes rather than thermodynamic changes.

Keywords: gcm, extreme, projection

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JMS011 **Poster presentation** **1103**

Daily precipitation-downscaling techniques in three chinese regions

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Brdossy Andrs, Chen Deliang, Halldin Sven, Xu Chong-Yu

Four methods of statistical downscaling of daily precipitation were evaluated on three catchments located in southern, eastern and central . The evaluation focused on seasonal variation of statistical properties of precipitation and indices describing the precipitation regime, e.g., maximum length of dry spell and maximum 5-day precipitation, as well as inter- and intra-annual variations of precipitation. The predictors used in this study were mean sea level pressure, geopotential heights at 1000, 850,700 and 500 hPa, and specific humidity as well as horizontal winds at 850, 700 and 500 hPa levels from the NCEP/NCAR-reanalysis with 2.5 x 2.5 resolution for 19612000. The predictand was daily precipitation from 13 stations. Two analogue methods, one using principal components analysis (PCA) and the other Teweles-Wobus scores (TWS), a multi-regression technique with a weather generator producing precipitation (SDSM) and a fuzzy-rule-based weather-pattern-classification method (MOFRBC), were used. Temporal and spatial properties of the predictors were carefully evaluated to derive the optimum setting for each method, and MOFRBC and SDSM were implemented in two modes, with and without humidity as predictor. The results showed that: (1) precipitation was most successfully downscaled in the southern and eastern catchments located close to the coast, (2) winter properties were generally better downscaled, (3) MOFRBC and SDSM performed overall better than the analogue methods, (4) the modeled inter-annual variation in precipitation was improved when humidity was added to the predictor set, and (5), the annual precipitation cycle was well captured with all methods.

Keywords: statistical, downscaling, precipitation

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JMS011 **Poster presentation** **1104**

A Baiu front observation with the MU radar spatial and frequency domain interferometry techniques

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The Baiu front is one of the most major seasonal phenomena which sometimes causes so much rainfall in Japan during June and July. The Baiu front passed over Japan on 18th and 19th July 2006, and it brought a new record rainfall of more than 400 mm at maximum for these two days in mid-Japan. The middle and upper atmosphere (MU) radar is one of atmospheric radars, which is located on Shigaraki, Japan, and is operated by the Research Institute for Sustainable Humanosphere(RISH), Kyoto University. We conducted the MU radar observation from 0500 to 1800 (LT) on 19th July, we found that the Baiu front passed over the MU radar around 0930 (LT), at the same time, vertical winds showed large variations and echo powers from atmosperic turbulences also showed strong up to 13 km altitude, which corresponds to a tropopause height. A C-band radar observation was also conducted at the MU radar observatory, and showed that rain drop echoes were widely distributed up to about 6 km without rain band, which indicated deep convections. After 0930(LT), horizontal winds changed from north-eastward to south-eastward, vertical wind variations showed smaller and tropopause height went down to around 10 km altitude, atmosperic turbelences showed stratiform structures. In the presentation, we will show wind variations, atmospheric turbulences, rain echoes before and after a passage of the Baiu front, and discuss their detail structures, time-height variations, and relations.

Keywords: mu radar, baiu, turbulence

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JMS011 **Poster presentation** **1105**

Analysis of intraseasonal and interannual variability of Asian summer monsoon using a Hidden Markov Model

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The Asian summer monsoon exhibits pronounced variability on various time scales. Among them, an irregular propagating intraseasonal oscillation (ISO) with a period of 3060 days is now considered as one of the most important phenomena to be challenged. Also, the interannual variability of seasonal mean monsoon circulation and its relationship with ENSO has been well recognized and investigated. While the ISO and ENSO-monsoon relationships have conventionally been considered separately, several recent studies have pointed to parallels in spatial structure, suggesting that interannual monsoon variability may be a residue of alteration of ISO phases. The relationship between the ISO and interannual variability is one of the key outstanding issues in the Asian monsoon studies. In the present study, intraseasonal and interannual variability of summer monsoon rainfall in the pentad precipitation data is examined in a simple but flexible probabilistic model. In contrast to most previous analyses, we build a probabilistic model that explicitly accounts for the stochastic aspect of atmospheric variability, and can be used to generate a large number of stochastic rainfall simulations for hypothesis testing. The modeling framework is provided by a Hidden Markov Model (HMM), in which a latent state variable (hidden state) is introduced to enable a simplified factorization of the probability distribution function (PDF) of pentad rainfall. The HMM selected consecutive phases of ISO as distinctive states and the transition probabilities among the states clearly support a cyclic transition of ISO phase. The transition probability of hidden states also suggests that re-initiation of ISO is more variable than other phases. In the stochastic simulation, the canonical ISO propagation and the level of irregularity are reasonably simulated by HMM. The interannual variation of ISO associated with ENSO is assessed by employing a nonhomogeneous HMM (NHMM). The NHMM results showed some noticeable aspects of interannual variability of ISO. The influence of ENSO onto the ISO is reflected as preferences of particular ISO phases depending on the ENSO condition. In the presence of seasonal mean interannual variability, El-Nino related seasonal mean state is able to be distinguished from the ISO states whereas La-Nina related state is not clearly identified or shares the spatial pattern with ISO states.

Keywords: iso, markov, enso

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JMS011 **Poster presentation** **1106**

Investigation of the Elevated Heat Pump Effect on the Asian Summer Monsoon Using Cloud Observations from METEOSAT-5

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Rachel T. Pinker

The onset and intensity of the Asian Summer Monsoon is influenced by many factors, including El Nino/Southern Oscillation, the Indian Ocean Dipole, and other dynamical conditions. Recently, a theory has been postulated that aerosol-induced anomalous mid- and upper-tropospheric warming above the Tibetan Plateau leads to early onset and a northwestward shift in monsoon rainfallthe so-called elevated heat pump effect (Lau et al. 2006). In particular, dust from western China, Afghanistan,Pakistan,and Southwest Asia, as well as black carbon emissions from sources in Northern India,are the driving forces behind the anomaly. This concept was developed based on results from multiple runs of the NASA finite-volume general circulation model with and without radiative forcing from different types of aerosols. This study takes an observational approach to detect signatures of the elevated heat pump effect in the cloud cover and cloud type distributions as derived from Meteosat-5 data over the Asian Monsoon region. Features will be compared for high- and low-aerosol content years.Lau, K. M., M. K. Kim, and K. M. Kim, 2006: Asian summer monsoon anomalies induced by aerosol direct forcing: the role of the Tibetan Plateau. J. Climate, 26, 855-864.

Keywords: monsoon, aerosols, clouds

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS012 **1107 - 1131**

Symposium
Planetary Atmospheres and Their Evolution

Convener : Prof. Darrell Strobel, Dr. Athena Coustenis
Co-Convener : Prof. Piergiorgio Casavecchia

Papers are invited which report important progress on all aspects of our current understanding of the evolution of atmospheres of all planets, moons and comets. The emphasis will be on insights gained from recent space missions, including Cassini and other satellites. Contributions describing the atmosphere-related objectives of the relevant missions, analysis of observations, and the results of model simulations of atmospheric evolution are also welcome. Invited Speakers: S. Atreya : "From Enceladus to Pluto: the Nitrogen content in the Outer Solar System" K. Baines : "Polar Views of the Deep Atmosphere of Saturn: New Insights into Waves, Storms, and Global Circulation from Cassini/VIMS" Nick Schneider: "Escape from Io and Enceladus" A. Coustenis : "Titan stratospheric composition" M. Dougherty : "MAG results on Enceladus" Th. Encrenaz : "Spectroscopy of the outer planetary atmospheres" F. Ferri : "Titan's atmospheric structure from Cassini-Huygens in situ measurements" M. Flasar : "Dynamics of Titan's Stratosphere inferred from CIRS data" M. Hirtzig : "Monitoring Titan's cloud activity during the last decade from Earth-based instruments and in-situ observations by Cassini" S. Lebonnois : "Review on the current state (successes and problems) of today's Titan GCMs" J-P. Lebreton : "Cassini-Huygens: past, present and future" J. Lunine : "The origin & evolution of Titan" F. Raulin: "Organic compounds in planetary atmospheres and the search for life" D. Strobel : "Titan Aeronomy" H. Niemann : "Huygens GCMS Results from Titan" T. Tokano : "Titan's Dynamic Meteorology" V. Vuitton : " Titan's ionospheric chemistry"

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JMS012 **Oral Presentation** **1107**

The stratospheric chemical composition of Titan

Dr. Athena Coustenis
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D. Jennings, C. Nixon, M. Flasar, A. Jolly, Y. Bnilan, D. Gautier, S. Vinatier, R. Achterberg, P. Romani, G. Bjoraker, B. Conrath

Titans stratosphere has been studied in the past from the Earth and also from space with Voyager, ISO and more recently Cassini observations. In particular, spectra recorded by the Composite Infrared Spectrometer (CIRS) aboard the Cassini spacecraft became available during the Titan flybys spanning two years now since SOI (Flasar et al., 2005; Teanby et al., 2006, Vinatier et al., 2006; Nixon et al., 2006; Coustenis et al., 2007). The spectra characterize various regions on Titan from 85S to 80N with a variety of emission angles. We have studied the emission observed in the CIRS detector arrays (covering the 10-1500 cm-1 spectral range with apodized resolutions of 2.54 or 0.53 cm-1). We have used temperature profiles retrieved from the inversion of the emission observed in the methane v4 band at 1304 cm-1 and a line-by-line radiative transfer code to infer the abundances of the trace constituents and some of their isotopes in Titan's stratosphere (Coustenis et al., 2007). The composite spectra show several signatures of previously identified molecules: hydrocarbons, nitriles, H2O and CO2. Besides these well-known trace species, a firm detection of benzene (C6H6) is provided by CIRS at 674 cm-1 and allows for the study of its latitudinal variations. No longitudinal variations were found for any of the gases. Information is retrieved on the meridional variations of the trace constituents and tied to predictions by dynamical-photochemical models (Hourdin et al., 2004; Lavvas et al., 2007). Molecules showing a significant enhancement at northern latitudes are the nitriles (HC3N, HCN) and the complex hydrocarbons (C4H2, C3H4). The D/H ratio on Titan was also determined from the CH3D band at 8.6 micron and found to be about 1.2 0.2 10-4. We have also identified the presence of C2HD at 678 cm-1 (Coustenis et al., 2006). Constraints are also set on the vertical distribution of C2H2. References : Coustenis et al., 2006, BAAS 38; Coustenis et al., 2007, Icarus, in press; Flasar et al., 2005, Science 308, 975 ; Hourdin et al., 2004, J. Geophys. Res. 109, E1205; Nixon et al., 2006, BAAS 38; Lavvas et al., 2007, Plan. Space Sci., submitted; Teanby et al., 2006, Icarus 181, 243; Vinatier et al., 2006, Icarus, in press.

Keywords: titan, composition, cassini huygens

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JMS012 **Oral Presentation** **1108**

Titans ionosphere as a source for aerosols

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Roger V Yelle

Titan has long been known to harbor the richest atmospheric chemistry in the solar system that culminates in the generation of thick haze layers. Until recently, it was believed that the bulk of the chemistry occurred in the stratosphere, where Far Ultra-Violet (FUV) solar radiation dissociates the major neutral species (nitrogen and methane). Minor hydrocarbon and nitriles would then subsequently be produced through neutral chemistry that would eventually lead to the formation of micrometer size organic aerosols. However, some discrepancies persist. For example, it has been difficult for photochemical models to reproduce the haze production altitude required by microphysical models. Recent measurements by the Cassini spacecraft are drastically changing our understanding of haze formation. The Ion and Neutral Mass Spectrometer (INMS) and the CAssini Plasma Spectrometer (CAPS) performed the first composition measurements of Titan's upper atmosphere. They revealed an extraordinary complex ionospheric composition. INMS detected roughly 50 ions with $m/z < 100$ and a density higher than 0.1 cm-3. CAPS provided evidence of heavy (100~350 amu) positively charged and negatively charged (20~8000 amu) ions. The Ultra-VIolet Spectrometer (UVIS) showed that the haze extends to 750 km altitude, and possibly higher. Based on this observational evidence and with added support from laboratory and modeling studies, we argue that aerosol growth starts in the ionosphere rather than at lower altitude. V. Vuitton, R.V. Yelle, V.G. Anicich, The nitrogen chemistry of Titan's upper atmosphere revealed. Astrophys. J. 647, L175-L178 (2006). V. Vuitton, R. V. Yelle and M.J. McEwan, Ion chemistry and N-containing molecules in Titans upper atmosphere, Icarus, submitted.

Keywords: ionospheres, organic chemistry, titan

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JMS012 **Oral Presentation** **1109**

Titans Dynamic Meteorology

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Saturns moon Titan represents a natural laboratory to investigate the behaviour of dynamic meteorology of an Earth-like dense atmosphere on a slowly rotating body. Until recently Titans dynamic meteorology was focused on the super-rotation and seasonally reversing meridional circulation in the stratosphere as evidenced by remote sensing and numerical modelling. On the other hand, the troposphere was expected to be calmer, although there were almost no observational constraints until the detection of tropospheric clouds and Cassini/Huygens began systematically exploring the world underneath the dense haze layer. Meanwhile various data of zonal, meridional and vertical wind as well as turbulence in the troposphere measured by the Huygens probe point to a much more dynamic troposphere than could be imagined after the Voyager mission. The most unexpected and challenging results include the circulation pattern in the lowermost part of the stratosphere characterised by weak horizontal wind and reversed meridional circulation. The troposphere is also the region in which Saturns gravitational tide and the methane hydrological cycle are supposed to have a substantial effect on the atmospheric motion. This paper reviews the current understanding of Titans dynamic meteorology with emphasis on the troposphere, considering in situ and remote observations of the troposphere and surface and predictions of global-scale and meso-scale models of atmospheric dynamics and convective clouds.

Keywords: titan, meteorology

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JMS012 **Oral Presentation** **1110**

The Origin and Evolution of Titan

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The ongoing Cassini-Huygens mission presents Saturn's largest moon Titan to us as a complex, almost paradoxical, world. Atmospheric particle- and photo-chemistry break up methane and, with the participation of nitrogen, produce a suite of complex hydrocarbons and nitriles that drift down to the surface in the form of aerosols--both solid and liquid. A large polar ethane haze and vast mid-latitudes dunes made of organic materials are the end-state evidence of this process. The rate of chemistry is such that Titan ought to have a long-term source of methane to resupply the atmosphere against loss by the energetic chemistry, and it is the nature of this reservoir that remains one of the outstanding mysteries associated with the origin and evolution of this world. Surface channels evidently cut by erosion appear on a variety of scales and suggest that liquid methane and perhaps ethane have run across the surface; in the equatorial site of the Huygens probe landing such features are evidently suppied by rainfall at times when the local environment is wetter in methane than it is today. The lakes discovered by Cassini RADAR at high northern latitudes are likely filled with methane, and provide a short-term source to re-wet the mid- and equatorial latitudes, but are not themselves the long-term source of methane. More likely is that methane was introduced during the formation of Titan, in a tepid circumsaturnian nebula, deep into the moon's interior, along with ammonia, as secondary components of a predominantly water-ice and rock world. The evolution of this configuration (Tobie, Lunine, Sotin, Nature v. 440, 61-64 2006) is that a liquid water-ammonia mantle quickly forms underneath a thin methane clathrate hydrate crust, with the rest of the interior being differentiated into a rocky core and various high pressure ice layers. The internal evolution of this configuration is such as to maintain a thin crust through 80-90% of Titan's history, with several episodes of outgassing supplying methane to the surface. If this model is correct, Titan's geology is largely that of a thin (but rigid) lithospheric planet on which topographic features may have relaxed and as well been reworked by erosion and buried by photochemical debris. Outstanding issues remain including whether isotopic and noble gas data from Cassini-Huygens are consistent with this picture.

Keywords: titan, solar system, volatile evolution

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JMS012 **Oral Presentation** **1111**

Dynamics of Titans Stratosphere

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We review results on Titans stratospheric temperatures and winds obtained from the Cassini Composite Infrared Spectrometer (CIRS) and Radio Science experiments. CIRS observations indicate that the stratosphere near 1 mbar is warmest at low latitudes, with the south pole a few degrees colder and the north pole in winter night ~20 K colder. Associated with the cold northern temperatures is a strong circumpolar wind system with speeds as high as ~160 m/s. Within this vortex, the mixing ratios of several organic gases are enhanced relative to those at low latitudes. The stratopause height increases from ~0.1-mbar near the equator to 0.01-mbar near the north pole, where it is the warmest part of the atmosphere. This implies subsidence at the pole, which is consistent with the enhanced organics observed. By the time of this talk, Cassini radio occultations will have sounded mid-southern latitudes and both polar regions. The occultation soundings occur quickly, and the retrieved profiles of stratospheric temperatures are very sensitive to small timing shifts in the spacecraft ephemeris, and in particular to the implied errors in spacecraft velocity. With their high vertical resolution, the occultation profiles are a good probe of wave propagation in the stratosphere.

Keywords: titan, temperatures, winds

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JMS012 **Oral Presentation** **1112**

Review on the current state (successes and problems) of today's Titan GCMs

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With the space missions and new generations Earth and space telescopes, the observations of Titan's atmospheric system reveal its high degree of complexity. In order to understand these observations, models need to include more and more processes, interacting with each others. Therefore, General Circulation Models (GCMs) of the atmosphere of Titan have been developed with increasing complexity over the last fifteen years. In this review, the different models developed around the world for Titan's atmosphere are presented, from surface up to the stratopause region, with top altitudes ranging from below the stratopause (250km) to the low mesosphere (500 km). Hypothesis, parameters, couplings, and the resulting limits for each model are discussed. With emphasis given to the stratosphere and the superrotation of zonal winds, the role of the different processes represented in the GCMs can be studied (coupling between the aerosols structure and the dynamics, distributions of stratospheric trace compounds, boundary conditions), as well as the resulting atmospheric behaviors: thermal structure, mean meridional and zonal circulation, angular momentum transport, atmospheric waves. What are the atmospheric main controls ? How may we go beyond models' current limits ? This review summarises some lessons that can be learned from the comparisons between these models, and with available observations.

Keywords: titan, atmosphere, dynamics

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JMS012 **Oral Presentation** **1113**

Discovery of a Dynamic Atmosphere at Enceladus from Cassini Magnetometer Observations

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Fritz Neubauer, Christopher Russell, Joachim Saur, Jared Leisner, Marcia Burton

Cassini magnetometer observations from three targeted flybys of Saturns icy moon Enceladus revealed the existence of a dynamic atmosphere. This unexpected detection was originally made on a distant flyby and was subsequently confirmed on two follow-on flybys one of which was very close, at a distance of 173km from the surface. The magnetic field observations from all three flybys will be described as well as their interpretation. The magnetometer data from the first flyby revealed a diffuse and extended atmosphere in contrast to observations from the second and third flybys which were consistent with local outgassing activity via a plume from the surface of the moon near its south pole, as confirmed by other Cassini instruments.

Keywords: enceladus, atmosphere, magnetometer

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JMS012 **Oral Presentation** **1114**

Simulation of Titans atmospheric processes and validation against Cassini/Huygens mission results.

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A coupled one-dimensional radiative-convective/photochemical/microphysical model is applied to the study of Titan's atmospheric processes that lead to haze formation. Our model generates the haze structure from the gaseous species photochemistry. Model results are presented for the species vertical concentration profiles, haze formation and its radiative properties, vertical temperature/density profiles and geometric albedo. These are validated against Cassini/Huygens observations and other ground-based and space-borne measurements. The model reproduces well most of the latest measurements from the Cassini/Huygens instruments for the chemical composition of Titan's atmosphere and the vertical profiles of the observed species. For the haze production we have included pathways that are based on pure hydrocarbons, pure nitriles and hydrocarbon/nitrile copolymers. From these, the nitrile and copolymer pathways provide the stronger contribution, in agreement with the results from the ACP instrument, which support the incorporation of nitrogen in the pyrolised haze structures. Our haze model reveals a new second major peak in the vertical profile of haze production rate between 500 and 900 km. This peak is produced by the copolymer family used and has important ramifications for the vertical atmospheric temperature profile and geometric albedo. In particular, the existence of this second peak determines the vertical profile of haze extinction. Our model results have been compared with the DISR retrieved haze extinction profiles and are found to be in very good agreement. We have also incorporated in our model heterogeneous chemistry on the haze particles that converts atomic hydrogen to molecular hydrogen. The resultant H2 profile is found to be in very good agreement with INMS measurements, while the vertical profile of the diacetylene formed is found to be closer to that of the CIRS profile when this heterogenous chemistry is included.

Keywords: photochemistry, microphysics, radiation

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JMS012 **Oral Presentation** **1115**

Titan Aeronomy

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The Cassini-Huygens Mission has provided an abundance of data pertaining to Titan's thermosphere and confirmed general conclusions from the Voyager Mission that CH4 is well mixed to high altitude and the thermosphere is cold (~ 150 K), with similar total densities at the equatorial 950 km level. However, the thermospheric structure is not consistent with the Voyager conclusion that only solar forcing and heating is important. Some of the surprises include 1) suggestive evidence for large non-thermal escape fluxes H2 and CH4, 2) large amplitude waves, 3) equatorial bulge above 950 km, 4) complex molecules and ions in abundances above 950 km far in excess expectations of pre-Cassini-Huygens photochemical models, 5) magnetospheric induced electrodynamic interaction down to the 1000 km level, and 6) significant high energy ion fluxes penetrating below 1000 km with important chemical and physical consequences. A selection of these topics will presented consistent with the allocated time.

Keywords: titan, satellite, atmosphere

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JMS012 **Oral Presentation** **1116**

Polar Views of the Deep Atmosphere of Saturn: New Insights into Waves, Storms, and Global Circulation from Cassini/VIMS

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We present recently-acquired imagery of cloud and wave systems spanning the depths of Saturn down to the 3-bar level in the polar regions of Saturn, obtained by the Visual Infrared Mapping Spectrometer (VIMS) onboard the Cassini/Huygens orbiter. Images taken in both reflected sunlight and in Saturns thermal glow at 5 microns wavelengths, will be presented. The 5-micron images reveal thick clouds at depth, seen silhouetted against the upwelling radiation. In the south polar region, a significant fraction of these deep discrete clouds appear surprisingly dark in reflected sunlight, indicating a nearly wavelength-independent dark absorber spanning the 0.5-3 um region exists in or above these clouds. These compositionally-different cloud regions then may indicate that unusually strong vertical upwelling occurs at discrete locations near the south pole. In the north polar region, Saturns Polar Hexagon, discovered in Voyager imagery by Godfrey (Icarus 76, 335-356, 1988), is a prominent feature at 5 microns, indicating that the feature is comprised of relatively large particles (> 1 micron) and extends at least several bars of pressure down into the atmosphere. The re-acqusition of this feature near 77.5 degrees planetocentric latitude indicates that the hexagon is a multi-decade, long-lived feature which survives the Saturn seasons. A second hexagon, significantly darker at 5 micron than the brighter historical feature, is located near 74.2 degrees planetocentric latitude. The clouds in the 5-micron-bright hexagon are relatively deep: 3.5 bars compared to the 2.5-3.0-bar level of clouds in the dark hexagon. Observed three times over a 12-day period between October 29 and November 10, 2006, both hexagonal features stay fixed in a rotational system defined by the Voyager-era radio rotation rate (Desch and Kaiser, Geophys. Res. Lett, 8, 253-256, 1981) to within an accuracy of 11 seconds per rotational period. This agrees with the stationary nature of the wave in this rotation system found by Godfrey (1988), but is inconsistent with more recent Saturn rotation rates found during the current Cassini era. Together with our new constraints on the depth of the feature, this result indicates that the feature is not linked to Saturns radio emissions nor to auroral activity as speculated by Godfrey. (1988). Images of these and other discrete features including the north polar aurarae - will be shown and discussed.

Keywords: saturn, dynamics, near infrared imagery

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JMS012 **Oral Presentation** **1117**

Monitoring Titan's cloud activity during the last decade from Earth-based instruments and in-situ observations by Cassini

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Titan's clouds and short-term atmospheric phenomena are particularly puzzling. Hints as to the presence of clouds on Titan have been found in spectra dating back to 1995 (Grifith et al., 1998), while their first direct detections from ground-based or HST observations can be found in images from 1999 and on (Gibbard et al., 1999; Roe et al., 2002; Hirtzig et al., 2005). Since then and until now, with the recent input from Cassini, many different features have been reported, in particular the huge meteorological system hovering above Titan's south pole, mid-latitude clouds and ethane clouds in the North. The physical processes behind the general picture are still difficult to comprehend since the whole picture of Titan's weather is very complicated and since different means of observation (spectroscopy, imaging) are used. The data interpretation is also still at an early stage since various teams use different models with varying parameters to analyze what they observe. Therefore, we will only present here an overview of all the clouds observations between 1996 and 2007 [Hirtzig et al. in prep], with indications on the location, altitude, etc. The set of all these observations, published throughout about 20 different papers, allows us to build a precise chronology of Titan's atmospheric changes (including the North-South Asymmetry). We will also briefly mention some of the current theories regarding the clouds nature. The knowledge of the weather timeline is thus a crucial constraint on the modeling and description of the methane cycle.

Keywords: titan, infrared, clouds

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JMS012 **Oral Presentation** **1118**

Zonal flows in Giant Planets: Anelastic Rotating Convection Models

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Dr Kirill Kuzanyan

The large scale zonal flows on Jupiter and Saturn may be due either to deep convection in the molecular H/He layer above the metallic hydrogen core or to forcing in the stably stratified zone near the surface. Boussinesq simulations of deep convection in a rapidly rotating spherical shell have been successful in reproducing the strong eastward current near the equator in both Jupiter and Saturn and the alternating bands of eastward and westward flow. However, the density varies by many orders of magnitude from the metallic hydrogen transition layer at around 2 Mbar to the 20 bar level reached by the Galileo probe. Here we examine the effects of this density variation in fully three-dimensional simulations of rapidly rotating convection in a spherical shell, using the anelastic approximation. We find that the equatorial eastward current that lies outside the tangent cylinder surrounding the magnetically dominated metallic hydrogen core still extends into the deep interior in anelastic models with large density variation. However, the alternating bands that lie inside the tangent cylinder are strongly affected by compressibility. As the surface is approached, the convective entropy fluctuation rises rapidly, giving rise to a large thermal wind in the upper parts of the deep atmosphere. This means that the azimuthal flow varies significantly with depth, so that the simple Proudman-Taylor effect of flow constant on cylinders no longer holds. We also examine the possible effects of the magnetic field on the weakly electrically conducting region above the metallic hydrogen core.

Keywords: zonal flow, giant planets, anelastic

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JMS012 **Oral Presentation** **1119**

Escape from Io and Enceladus

Prof. Nick Schneider
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Our understanding of atmospheric escape is most readily tested at small bodies where the escape is so rapid that it can be directly measured. Io and Enceladus offer two distinct and insightful examples. On Io, extensive volcanic outgassing supplies an ephemeral atmosphere, most of which condenses on the surface and a very small fraction escapes. The small fraction is still a large amount in absolute terms: ~1 ton/sec. This loss of SO2 has profound effects on Jupiter's magnetosphere, and has stripped away ~2km of Io's radius over the age of the solar system. The loss of other species early on could have had an even larger effect. Enceladus, by contrast, appears to vent material directly onto escape trajectories. Its estimated loss rate of ~300 kg/sec gives it about 30% of Io's loss rate despite having only 0.1% of the mass; at this rate Enceladus would vanish in 8 billion years. Escape from Enceladus also populates the E ring and influences Saturn's magnetosphere. We will review observational and theortical work on escape from these two bodies, and contrast the two styles. We will also present preliminary results from recent observing campaigns: measurements of Io's atmospheric escape during the New Horizons Jupiter encounter, and a search for emissions from gas escaping from Enceladus. This work has been supported by NSF's Planetary Astronomy Program.

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JMS012 **Oral Presentation** **1120**

From Enceladus to Pluto: Origin of nitrogen on small bodies of the solar system

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ICPAE Past President of ICPAE IAMAS

Nitrogen is one of the main elements of the building blocks of life as we know it. It is the fifth most abundant elements in the solar system. and, it is indeed ubiquitous. In the reducing atmospheres of the giant planets, it is found in the form of ammonia, but presumably delivered to them originally as nitrogen (N2). On the contrary, nitrogen in the atmospheres of the terrestrial planets Titan and Enceladus is secondary. The planetesimals that formed these bodies delivered ammonia, which was converted to nitrogen. With the exception of Enceladus, such conversion must have occurred in the primordial past of these bodies. Photodissociation of ammonia is an effective means of turning NH3 into N2 under appropriate conditions. Thermal dissociation could play a role also. On Titan, 5-8 bars of the original nitrogen atmosphere could be produced on timescales of the order of ten million years by photolysis of NH3 [1,2]. Because of its low gravity, Enceladus cannot have a bound atmosphere, therefore its nitrogen must be produced now. Thermal dissociation of ammonia in Enceladus' hot interior seems to be at play [3]. The extremely low temperatures of Triton and Pluto do not permit ammonia to exist in gas phase, thus its dissociation is not a path to their nitrogen. N2 on Pluto and Triton must be primordial. [email: webpage for downloading pdf's:] [1] Atreya, S. K., et al., Science 201, 611, 1978. [2] Wilson, E.H., Thesis, Univ. Michigan, 2002; Adams, L., Thesis, Univ. Michigan, 2006. [3] Castillo, J., et al., in press. 2007.

Keywords: titanenceladustritonpluton2

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JMS012 **Oral Presentation** **1121**

A 3D turbulent convection model of zonal flow on the Ice Giants

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Previous studies have used models of three-dimensional (3D) Boussinesq convection in a rotating spherical shell to explain the zonal flows on the Gas Giants, Jupiter and Saturn. However, this approach can also generate flow patterns similar to those observed on the Ice Giants, Uranus and Neptune. The equatorial jets of Uranus and Neptune are often assumed to result from baroclinic cloud layer processes and have been simulated with shallow layer models. We show that vigorous, 3D convection in a spherical shell can produce the retrograde (westward) equatorial flows that occur on the Ice Giants as well as the prograde (eastward) equatorial flows of the Gas Giants. In our models, the direction of the equatorial jet depends on the ratio of buoyancy to Coriolis forces in the system. In cases where Coriolis forces dominate buoyancy, cylindrical Reynolds stresses drive prograde equatorial jets. As buoyancy forces approach and exceed Coriolis forces, the cylindrical nature of the flow is lost and 3D mixing homogenizes the fluid's angular momentum; the equatorial jet reverses direction, while strong prograde jets form in the polar regions. Although the results suggest that conditions involving strong atmospheric mixing are responsible for generating the zonal flows on the Ice Giants, our present models require roughly 100 and 10 times the internal heat fluxes observed on Uranus and Neptune, respectively.

Keywords: atmospheres, convection, zonal jets

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JMS012 **Oral Presentation** **1122**

Cassini Radio Occultations of Titans Atmosphere: Comparative Extinction Observations

Prof. Essam Marouf

Richard French, Michael Flasar, Paul Schinder, Arvydas Kliore, Nicole Rappaport, Colleen Mcghee, Aseel Anabtawi

We report on preliminary results from the first atmospheric radio occultation experiment ever to probe the high-northern and high-southern latitudes of Titan, to be conducted on March 25, 2007 (T27). The results are comparatively considered in the context of two similar Cassini experiments completed on March 18 (T12) and May 20 (T14), 2006. In both cases, the atmosphere was probed on the ingress and egress sides, yielding observations at four mid-southern latitudes. In all cases, quasi-monochromatic S-, X-, and Ka-band signals (13, 3.6, and 0.94 cm-wavelength, respectively) are transmitted from Cassini, and the perturbed signals are observed at the ground receiving stations of the NASA Deep Space Network. For T12 and T14, the refracted S- and X-band signals were tracked down to Titans surface. In contrast, the Ka-band signal was extinguished by atmospheric absorption at about 10 km above Titans surface. Changes of signal strength, corrected to remove refractive defocusing, reveal both small-scale and large-scale effects. The former are likely due to gravity waves and turbulence. The latter exhibit remarkable differential extinction of the three radio signals, an attribute of Titans atmosphere observed for the first time. Abel inversion of signal extinction integrated over the radio path yields altitude profiles of the local extinction coefficient (dB/km), revealing distinct behavior in the stratosphere and in the troposphere. The profiles appear remarkably consistent among the ingress and egress sides and also among the T12 and T14 observations and clearly illustrate the strongly dispersive nature of the responsible physical mechanism. We investigate and discount extinction by methane rain droplets as the main mechanism for the observed tropospheric differential extinction. We show that N2-N2 collision-induced gaseous absorption is most likely the dominant responsible mechanism, although additional extinction due to rain droplets or other localized sources is a possibility. Investigation of physical mechanisms responsible for the observed stratospheric extinction is in progress.

Keywords: titan, cassini, radio occultation

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JMS012 **Oral Presentation** **1123**

Titan's atmospheric structure from Cassini-Huygens in situ measurements

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During the Huygens probe mission at Titan on 14th January 2005, the Huygens Atmospheric Structure Instrument (HASI) obtained measurements of atmospheric properties from about 1500 km down to the ground, thus inferring the atmospheric structure. The atmospheric profile along the Huygens probe trajectory during entry phase has been retrieved from the accelerometers data, while below 160 km direct pressure and temperature measurements have been performed. The atmosphere was detected by HASI at an altitude level of about 1500 km; pressure and temperature vertical profiles have been retrieved starting from the exobase (estimated to be at ~1380 km) using the assumption of hydrostatic equilibrium. The upper atmosphere was warmer than predicted [Yelle et al. 1997]; several temperature variations have been observed in thermosphere possibly related to inversion layers and other dynamical effects such as gravity or tidal waves [Strobel, 2006]. The stratopause, which was detected near 250 km, had a temperature of ~187 K and a pressure of about 0.3 hPa.The temperature structure of the lower atmosphere is in very good agreement with the Voyager 1 RSS and IRIS measurements [Lindal et al. 1983, Lellouch et al. 1989]. The tropopause, at the altitude level of ~44 km (at pressure of 1151hPa) had a temperature of (70.430.25)K. The meteorological conditions monitored at the surface of Titan for almost half an hour, resulted in a mean temperature value of 93.650.25 K and pressure of 14671 hPa. Meteorological interpretation of HASI data leaded to the determination of the presence of a weakly convective Planetary Boundary Layer (PBL) of 300 m [Tokano et al. 2006] also confirmed by the correlation with Huygens DWE data. The temperature and density profiles retrieved from HASI data, provide an accurate determination of the whole atmosphere (from exobase down to ground) and parameters for a very precise characterization of the chemical structure. The thermal structure and stability of Titans atmosphere will be discussed also in relation with the results of ground based observations and remote sensing observations by Cassini. References Lellouch, E. et al. Icarus 79, 328-349 (1989). Lindal, G.F. et al. Icarus, 53, 348-363 (1983). Strobel, D. Icarus 182, 331-350 (2006). Tokano T. et al JGR 111, (2006). Yelle R.V. et al. ESA-SP-1177, European Space Agency (1977).

Keywords: titan, atmosphere, structure

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JMS012 **Oral Presentation** **1124**

Huygens GCMS Results from Titan

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Sushil Atreya, Jaime Demick, Wayne Kasprzak, Tobias Owen, The Gcms Team

The Huygens Probe executed a successful entry, descent and impact on the Saturnian moon of Titan on January 14, 2005. The Gas Chromatograph Mass Spectrometer (GCMS) was an instrument payload on the Huygens Probe, and conducted isotopic and compositional measurements throughout the two and one half hour descent from 146 km altitude and on the surface for 69 minutes until loss of signal from the orbiting Cassini spacecraft. The GCMS employed a quadrupole mass filter with a secondary electron multiplier detection system and a gas sampling system providing continuous direct atmospheric composition measurements and batch sampling through three gas chromatographic (GC) columns, a chemical scrubber and a hydrocarbon enrichment cell. The GCMS gas inlet was heated to prevent condensation, and to evaporate volatiles from the surface after impact. Data products from the GCMS included altitude profiles of the major atmospheric constituents dinitrogen (N2) and methane (CH4), isotope ratios of 14N/15N, 12C/13C, and D/H, mole fractions of radiogenic argon (40Ar) and primordial argon (36Ar), and upper limits on the mole fractions of neon, krypton and xenon, which were found to be absent. Surface measurements confirmed the presence of ethane (C2H6) and cyanogen (C2N2). Later data products expanded atmospheric profiles to include the surface response of C2N2, C2H6, acetylene (C2H2), and carbon dioxide (CO2). More recent results include the profiles of benzene (C6H6) and molecular hydrogen (H2).

Keywords: titan, atmosphere, spectrometer

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JMS012 **Oral Presentation** **1125**

Spectroscopy of outer planetary atmospheres

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Three classes of atmospheric constituents are found in the giant planets: (1) tropospheric species, (H2, He, CH4, NH3, H2O, PH3, GeH4, AsH3, possibly CO) ; (2) stratospheric hydrocarbons, products of the methane photodissociation (C2H6, C2H2, C2H4,...) ; and (3) stratospheric species coming from an external oxygen source, either local or interplanetary (H2O, CO, CO2). H3+ is the only ion detected in the giant planets' ionospheres. Spectroscopic observations are our most precious tool for characterizing the atmospheres of the outer planets. UV and visible radiation probes ions and radicals in the upper atmospheres, while the infrared range is best suited for the study of neutral atmospheres. The spectrum of a planet has two parts : the sunlight component, reflected or scattered back in the observer's direction (which peaks in the visible range), and the thermal emission corresponding to the absorbed part of the solar incoming radiation (which extends in the middle and far infrared). The solar component allows us to identify planetary atmospheric species which show absorption signatures in front of the solar continuum. The thermal spectrum strongly depends upon the temperature of the atmosphere and bears significant information on the chemical atmospheric composition, the temperature structure and the cloud structure. A comparative analysis of giant planet spectra will be shown, with a comparative analysis of their similarities and differences.

Keywords: planetary atmospheres, infrared spectroscopy

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JMS012 **Oral Presentation** **1126**

Cassini-Huygens: past, present and future exploration of Saturn and Titan.

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Following the successful exploration of Saturn in the late 70s early 80s by Pioneer 11 and the Voyagers, Cassini-Huygens, launched in 1997, is now exploring Saturns system for more than 2 years after successful orbit insertion on 1st July 2004. It provides us with a new view of this rich and complex ring world. Huygens, which successfully landed on Titan surface on 14 January 2005, provided us with extraordinary views of Saturns largest moon surface and performed in-situ measurements of the atmosphere structure, composition and dynamics during entry and its 2 hour descent under parachute. Critical observations of Huygens radio signal were provided by Radio astronomers on Earth. After more than 25 close flybys of Titan by the Cassini Orbiter, a new understanding of Titan, the Solar System object that is more Earth-like than any other body in the solar system is emerging. Highlights of the results obtained so far by Cassini-Huygens at Saturn, with emphasis on Titan will be presented. The status of the Mission will be discussed. The future exploration of Saturn and Titan will be briefly discussed in the context of both an extended Cassini mission and of post-Cassini Huygens mission concepts.

Keywords: saturn titan, planetary system, cassini huygens

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JMS012 **Poster presentation** **1127**

A three element atmosphere model

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The possibility of modeling the terrestrial atmosphere using only three elements: hydrogen, oxygen and nitrogen is examined. The molecular, atomic and combined compounds of these elements are considered to explain the complex chemistry of the atmosphere. . For the undisturbed situation the atmosphere constituents are radially distributed under hydrostatic equilibrium and horizontal stratification. The solar energy combined with the earths rotation produces the dynamical behavior of the atmosphere. The additional fate of the solar energy is absorption, transfer and reflection to the outer space. The absorbed energy produces chemical transformation of the equilibrium atmospheric constituents.

Keywords: atmosphere, composition

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JMS012 **Poster presentation** **1128**

Organic chemistry on Titan: astrobiological implications

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LISA Univ Paris 12 - CNRS IAMAS

Patrice Coll, Mai-Julie Nguyen

After less than three years of close observation by remote sensing and in situ instrumentations from the Cassini-Huygens mission, Titan looks more and more as one of the key planetary bodies in the solar system for astrobiological studies. Titan presents many analogies with an evolving planet, been geologically active, with cryovolcanism, eolian erosion, clouds and precipitations, and a methane cycle very similar to the water cycle on Earth.But the new data also show that a very complex organic chemistry is taking place in the very high atmospheric zones of the satellite, with the formation in the ionosphere of high molecular weight organics feeding the lower zones with these compounds, down to the surface. In this scheme, aerosols seems to play a key role.The data obtained from the collect and analysis of the stratospheric and tropospheric aerosols of Titan by ACP and GC-MS on Huygens show that the particles are made of a refractory organic part, the composition of which looks very close to the laboratory tholins, solid organic products obtained during laboratory simulation of Titan's atmosphere chemistry. New laboratory studies have been performed on Titan tholins: - Study of the 12C/13C ratios, compared to the ratio in the starting methane shows a potentially very small isotopic fractionation in tholins: this provides new constraints for the retrieving of ACP/GC-MS data.- Study of their evolution in the presence of water within different conditions of pH and temperatures show that the hydrolysis of tholins releases many organic compounds, mainly carboxylic acids, alcohols, amino acids and urea. Extrapolation of these data to Titan conditions strongly suggests that Titan's aerosols once deposited on Titan's surface could evolve in contact with water ice and form organic molecules of biological interest. This evolution may explain the reflectance spectum of Titan's surface observed by the DIRS instrument on Huygens, although, the lack of spectrosocopic data in the near IR makes difficult the retrieving of these data. Thus, contray to what was expected, the organic chemistry on Titan seems mainly concentrated in the ionosphere, in the aerosols, and on the surface.These aspects will be examined, some of the associated questions will be answered on the basis of the already available Cassini-Huygens data. The needed post Cassini exploration and the associated future instrumentation will be also discussed.

Keywords: astrobiology, titan, tholins

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JMS012 **Poster presentation** **1129**

A 3D convective turbulence model of the zonal jets on Jupiter and Saturn

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Moritz H. Heimpel, Johannes Wicht

We show that deep convection in a spherical shell can generate zonal flow comparable to that observed on Jupiter and Saturn, including a broad prograde equatorial jet and multiple alternating jets at higher latitudes. Fully turbulent, 3D spherical numerical simulations of rapidly rotating convection with different spherical shell geometries have been carried out. The resulting global flow fields tend to be segregated into three regions (north, equatorial, and south), bounded by the tangent cylinder that circumscribes the inner boundary equator. In all of our simulations a strong prograde equatorial jet forms outside the tangent cylinder, whereas multiple jets form in the northern and southern hemispheres, inside the tangent cylinder. The jet scaling of our numerical models and of Jupiter and Saturn is consistent with the theory of geostrophic turbulence, which we extend to include the effect of spherical shell geometry. Zonal flow in a spherical shell is distinguished from that in a full sphere or a shallow layer by the effect of the tangent cylinder, which marks a reversal in the sign of the planetary $beta$-parameter and a jump in the Rhines length. This jump is manifest in the numerical simulations as a sharp equatorward increase in jet widths -- a transition that is also observed on Jupiter and Saturn. The location of this transition gives an estimate of the depth of zonal flow, which seems to be consistent with current models of the Jovian and Saturnian interiors.

Keywords: atmospheres, turbulence, jets

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JMS012 **Poster presentation** **1130**

Meteor detection using complex wavelets

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Mesosphere Stratosphere Troposphere (MST) Radar is a high power pulse coded phase coherent VHF Radar, employing advanced signal and data processing techniques. A major MST Radar facility intended primarily for studies on low latitude middle atmosphere has been established at Gadanki, in 1993. The operating frequency of the MST Radar is 53MHz with a peak power aperture product of 3x1010 Wm2. Atmospheric radar signal means the signal received by the Radar due to the back scattering property of the atmospheric layers. Generally the received back scatter signals otherwise called as Radar returns are very much associated with Gaussian noise. The noise dominates the signal as the distance between the radar and target increases and this led to decrease in Signal to Noise Ratio. Meteor detection meant identifying and separating the scans that contain meteors from the normal ones. The occurrence of the radar meteor echoes is a sporadic phenomenon. Meteor concept is a random phenomenon. i.e., the day, month and year of their occurrence can be stated precisely but at which particular time in a day they occur can't be said. Even though it has been observed for several years, the 'Peak event' pinpoint time can't be stated accurately. Only the 'Day of Peak Event' (DPE) can be stated. The above statements strongly describe the Degree of Randomness of the phenomenon. Different methods are designed for meteor detection in the past. All of them have got their own limitations. In this paper, we introduce new signal processing techniques to detect meteors, which provide very precise detection even for very low signal-to-noise ratio (SNR) meteor return signals. Complex wavelet based signal processing techniques for the meteor detection and the interference removal is more effective than the existing methods. This can detect even very weak meteor events also with high accuracy. A great improvement in the characteristics of the meteor events is observed when processed with complex wavelet based signal processing techniques. Experimental results show that we detect about 20% more meteor events comparing to that of traditional method. Also the whole meteor detection and interference removal processes are done by automated fashion, which saves us a lot of processing time. This approach also yields the best deceleration and that, when combined with a high level of detectability, yields results that exceed previous work in accuracy. Complex wavelets (constructing filterbanks based on Hilbert transform concept) that allow detecting certain parameters related to different Doppler frequency components. When the parameters exceed a certain threshold, we declare meteor detection. Meteor Detection Function (MDF) is defined using the above stated techniques. MDF gives the Meteor count, Time of occurrence, Meteor scan number. MDF is a unique function and it is very useful in Astronomical studies. The advantages of this method are directly derived from the limitations of the existing methods. Weak meteors can be efficiently detected, No need of intense observation on the data for threshold setting, the effect of 'Noise' and 'Interference' is also reduced to a greater extent.

Keywords: meteor, complexwavelets

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JMS012 **Poster presentation** **1131**

Will Titan lose its veil?

Prof. Vasili Dimitrov
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Methane CH4 is the only highly reactive and short-lived background component in Titans atmosphere, so its overall reserve predetermines both features and duration of atmospheric chemical activity. Titan's global chemical activity is considered in terms of methane cycle. One cycle is defined as a period T0=7.0.1014s of complete photochemical destruction of methane's observable atmospheric content CH40= 2.33.1017 kg [1]. Cycle duration T0, number of the past NP=20020, future NF=500 50 and total Nmax=NP+NF=70070 cycles are the main quantitative indices of the global chemical activity [2]. The fact that the period T0 is much smaller than the Titan's lifetime Tcur=1.42.1017s implies that the current methane content CH40 is continuously replenished by methane global circulation. There are two sources of methane replenishment, i.e. the recycling of the primordial reserve trapped in Titans interior as the clathrates, and the ground liquid-phase reduction of non-saturated final products of the atmospheric photochemical process. Internal reserve provides the dominant portion (~95%) of general recycle, while the reduction reconversion is the minor constituent of the global balance. Yet, there is the problem of the availability of the off-the shelf trapped methane. For the total trapped stock (CH4)max=(15.3-33.3).1020 kg, the continuous atmospheric activity during the whole Titan's life TSun~5.0.1017s can be provided if the accessible methane bulk (CH4)crit=α.(CH4)max exceeds the crucial value (CH4)crit≥1.65.1020 kg. This demand can be fulfilled if the clathrate cage-filling efficiency α equals respectively to α ≥αcrit1= (TSun/T0).[(CH4)0/[(CH4)max1] = 5.45.10-3 α ≥ αcrit2= (TSun/T0).[(CH4)0/[(CH4)max2] = 2.51.10-3 Thus, the total stock (CH4)max and α-values 5.45.10-3=αcrit2≥α≥αcrit1=2.51.10-3{kg CH4/kg clathrate} assign the critical value (CH4)crit≥1.65.1020 kg that in turn predetermine the very fate of Titan's veil. If the real accessible stock (CH4)real≤ (CH4)crit than the Titan will lose its veil inevitably (scenario of the "mosaic history"), otherwise (CH4)real≥(CH4)crit the veil survives down to Titan's dying day ("continuous history"). The specification of α seems to be one of the most relevant problems of the experimental modeling of Titans chemistry.

Keywords: methane cycle, clathrate, cage filling efficiency

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JMS013 **1132 - 1170**

Symposium
Aeronomy of Planetary Atmospheres: Comparative Planetology

Convener : Dr. Dmitry Titov, Prof. Darrell Strobel, Dr. Athena Coustenis
Co-Convener : Prof. Piergiorgio Casavecchia

Papers are invited on the physics and chemistry of the lower, middle and upper atmosphere and ionosphere of the inner and outer planets and their satellites. Studies of comparative atmospheres, including the atmospheres of Venus, Earth, and Mars, are also invited, with emphasis on the differences and similarities in their climates. Results from recent missions to Mars and the outer planets are of particular interest. Reports on improvement in general circulation models of the thermosphere and lower atmospheres of the planets and descriptions of future planetary missions are also invited. Invited Speakers A. Coradini: "Kuiper Belt Objects and Comets : links and thermal evolution" J-P. Bibring : "Mars : new view on the planet history" J-L. Bertaux (O.Korablev) :"Structure and composition of the Venus upper atmosphere" E.Chassefire : "Interaction with the solar wind and escape processes on terrestrial planets" P. Drossart: "Non-LTE emissions in the upper atmospheres of terrestrial planets" F. Forget: "Modeling of the general circulation on terrestrial planets" D. Grinspoon: "Coupled Climate/Surface/Interior Evolution of Venus" D. McCleese : "First results of the atmospheric sounding from MRO" G. Piccioni: "Dynamical phenomena in the Venus atmosphere observed by VIRTIS/VEX" H. Svedhem: "Venus Express: results of the one year in orbit" F. Taylor: "The Present Climate of Venus" D. Titov: "Radiation on the atmospheres of terrestrial planets" N. Balucani: "Gas-phase neutral-neutral reactions in planetary atmospheres" J. Brucato: "Catalytic effects of dust at cryogenic temperatures" O. Dutuit : "Titan Ionospheric Chemistry" W. Geppert : "Dissociative recombination - an efficient degradation way of ions in planetary ionospheres with often unexpected products" R. Kaiser: "Towards the Formation of PAHs in Titan's Atmosphere" S. Le Picard: "Low-temperature rate constants for neutral reactions of relevance to Titan's atmosphere" M. Smith: "The role of photoionization in the formation of complex organic molecules in Titan's upper atmosphere" M. Snels: "Laboratory measurements of spectral properties of the atmospheric gases" (TBC) B. Bzard: "Spectroscopic issues related to infrared investigations of planetary atmospheres"

JMS013 **Oral Presentation** **1132**

The regular thin structure of the upper cloud layer of Venus northern polar atmosphere observed from radio occultation data

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Andreev, V.E., Pavelyev, A.G.

The scintillations observed in radio waves propagating through the atmosphere of Venus represent an important tool for measuring small-scale irregularities in the atmosphere of this planet. The outstanding feature is the upper region of enhanced scintillations located in the vicinity of 60 km. It is assumed now, that the enhanced scintillations are due to the random turbulence in the upper region which is caused by trapped small-scale gravity waves. But other interpretations are possible. Thin stable layers are commonly observed in the Earth stratosphere under cloud-free conditions could also contribute to scattering in Venus stratosphere. If the scintillations observed in the different occultations are correlated, then these scintillations may be attributed to the persistent layers. The results of cross-correlation analysis of the amplitude fluctuations of radio waves of 32 cm band in seven sessions of radio occultation measurements of the northern polar atmosphere of planet using Venera 15 and 16 are presented. The existence of the cross-correlation of fluctuations (coefficient of cross-correlation is about 0.6-0.7) is established in the altitude realizations in the interval 61.5-65.0 km for 4 different sessions of radio occultation. Inner layering is revealed in the upper layer of the clouds of the planet at altitudes of 61.5-65.0 km, which is specified by an enhanced turbulence of the atmosphere. It is found that the lifetime of the small-scale layered irregularities is no less than 2 days and that their horizontal extension in the meridional direction can exceed 130 km. A possible cause of the emergence of the layered structures inside the upper layer of the polar clouds of Venus is discussed.

Keywords: occultation, layers, venus

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JMS013 **Oral Presentation** **1133**

The role of photoionization in the formation of complex organic molecules in Titans upper atmosphere

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Chemistry University of Arizona IAMAS

Hiroshi Imanaka

Recent observations by the Cassini Orbiter suggest that complex organic chemistry is prevalent in the ionosphere of Titan. To understand the role of EUV-VUV light in the complex organic chemistry of Titans upper atmosphere, we investigate the formation of gaseous species from N2/CH4 gas mixtures as a function of irradiation wavelengths from 50 nm to 150 nm, using narrowband(1%) light from the Advanced Light Source at the Lawrence Berkeley Lab. The analysis of gaseous products by quadrupole mass spectrometry reveals the formation of heavy organics up to C7 to C8 by EUV light irradiation. In particular, the efficient formation of benzene and other aromatics is observed at wavelengths less than 80 nm, which is well correlated to photoionization of N2. In Titans upper atmosphere, EUV radiation may play an important role in the formation of complex organic molecules through photoionization of N2. We suggest that the dissociative charge transfer of N2+ with methane to produce CH3+ is critical to the schemes producing unsaturated organics in this region. Using this same experiment we can make particular conclusions regarding the rates and mechanisms for the fixation of nitrogen into complex organic molecules from various wavelength regions in the EUV.

Keywords: titan, photoionization, chemistry

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JMS013 **Oral Presentation** **1134**

Titan ionospheric chemistry, laboratory experiments and uncertainty propagation, tools for improving models

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ICPAE ICPAE IAMAS

Thissen Roland, Alcaraz Christian, Carrasco Nathalie, Pernot Pascal

We describe results of a concerted research effort held in Laboratoire de Plantologie de Grenoble and "Laboratoire de Chimie Physique", where experimentalists as well as theoreticians, have developed laboratory tools in order to measure accurate rates of ion molecule reactions, and tools to estimate the uncertainty propagation in the models of Titan Ionospheric Chemistry, which are becoming increasingly complex. Laboratory measurement results will be presented for energy-selected (internal and translational energy) ion-molecule reactions and doubly charged molecular ion reactions. We will also present a new project with an experimental set-up, which will be installed in a near future in "Laboratoire de Plantologie de Grenoble". A very high-resolution mass spectrometer is proposed to study the Titan ionosphere Chemistry, in particular the molecular growth paths leading to big molecular ions observed by the INMS instrument on board Cassini. A parallel modeling effort with uncertainty analysis will be conducted in Orsay and Grenoble.

Keywords: titan, ionosphere, chemistry

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JMS013 **Oral Presentation** **1135**

Spectroscopic issues related to infrared investigations of planetary atmospheres

Dr. Bruno Bézard
LESIA Observatoire de Paris IAMAS

Infrared spectroscopic observations of planetary atmospheres allow us to retrieve horizontal and vertical distributions of temperature, particles, and gas compounds. The analysis of such data relies on radiative transfer models that in turn require precise spectroscopic information on the relevant absorbers. Important information is still missing in this regard and calls for laboratory measurements and spectroscopic analyses. Specific needs, connected to the present exploration of Venus, Mars and the Saturn system by the Venus Express, Mars Express and Cassini/Huygens missions, will be discussed. These include measurements of methane and carbon dioxide absorption at very long pathlengths in near-infrared spectral windows and spectroscopic analyses of some specific rovibrational bands in the thermal infrared range.

Keywords: infrared, spectroscopy, atmospheres

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JMS013 **Oral Presentation** **1136**

Seasonal changes of the baroclinic wave activity in the northern hemisphere of Mars simulated with a General Circulation Model

Dr. Takeshi Kuroda
IAMAS

Alexander S. Medvedev, Paul Hartogh, Masaaki Takahashi

Seasonal changes in baroclinic wave activity during northern autumns and winters are studied with a Martian general circulation model. For the weak dust load, the simulated s=2 (zonal wavenumber of 2) harmonic with 3.1 sols period dominates near the surface, while s=1 (zonal wavenumber of 1) with 5.5 sols period is more prominent higher during autumns. In winters, the s=1 wave has stronger amplitudes and a deep (up to 0.1 mb) vertical structure. These simulations are consistent with observations from MGS. These changes can be explained by the seasonal variations of the zonal mean wind and temperature, and by the related generation and propagation of waves. The model reproduced the observed significant reduction of disturbances during strong dust storms. It occurs due to the stabilization of the jet stream and the associated weakening of the wave excitation.

Keywords: mars, planetary waves, general circulation model

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JMS013 **Oral Presentation** **1137**

Dissociative recombination of nitrogen-containing ions detected in titans ionosphere

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Ion reactions are amongst the most crucial processes in upper layers of planetary atmospheres. During the Cassini-Huygens mission, nitrogen-containing ions have been detected in Titans ionosphere to a greater extent than was predicted by previous model calculations (Vuitton, Yelle & Anicich, Astrophys. J. Lett. 647, 175 (2006)). Especially cyano compounds like protonated acetonitrile are likely to play a major role there. Dissociative recombination is a major pathway of degradation of ionospheric anions and is rates and is therefore included in model calculation of reaction networks for such environments. Unfortunately, very often experimental data on rates branching ratios of this process is lacking even for the most important species. This is aggravated by the fact that, due to their exoergicity, dissociative recombination reactions usually can have several pathways leading to very different products and the relative importance of these channels has often proved quite surprising. We present branching ratios and rates of the dissociative recombination of some ions with special significance for planetary ionospheres, including protonated nitriles observed in Titan's ionosphere.

Keywords: ionospheres, titan, recombination

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JMS013 **Oral Presentation** **1138**

Effects of thermal tides on the Venus atmospheric superrotation

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Yoshihisa Matsuda

A generation mechanism of the Venus atmospheric superrotation proposed by Takagi and Matsuda (2006) has been examined by a nonlinear dynamical model on the sphere. The result shows that the mean zonal flow extending from the ground to 80 km, which is similar to the observations, is generated and maintained by the momentum transport associated with the thermal tides. Namely, the downward transport of zonal momentum which is associated with the downward propagating semidiurnal tide excited in the cloud layer induces the mean zonal flow opposite to the Venus rotation in the lowest layer adjacent to the ground. Surface friction acting on this counter flow provides the atmosphere with the net angular momentum from the solid part of Venus.

Keywords: superrotation, venus

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS013 **Oral Presentation** **1139**

The Mars Canadian, Climate and Composition Mission (MCCCM)

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Peter Bernath, Dylan Jones, Jacek Kaminski, E.J. Llewellyn, Kimberly Strong, Kaley Walker, William Ward, Thomas Duck

The atmosphere of Mars bears some striking similarities to that of Earth, but also some equally striking differences. Considering the wealth of information that is contained in the atmosphere concerning the history and current state of the atmosphere, it is surprising that more missions have not identified the atmosphere of the planet as a primary target. The MCCCM mission study is an attempt to bridge that gap by using instrumentation similar to that used for the Earths atmosphere for the planet Mars. The overall theme of the MCCCM mission is The composition and climate of the Martian Atmosphere. The goals are: 1) To determine the composition of the atmosphere of Mars. The major constituents are known. The minor constituents and their concentration profiles are of great interest. 2) To understand the extent and function of aerosols in the atmosphere of Mars. . Both non-condensing aerosol (dust) and condensing aerosol (clouds) are important in understanding the current state of the atmosphere. 3) To determine the current dynamic state of the atmosphere of Mars. The dynamic state of the atmosphere is necessary to understand the weather as well as the climate of Mars. Four instruments have been identified for this mission: a Fourier Transform Spectrometer (FTS) which is based on the unit flown on Canadas SciSat mission; an Imager the Mars Imager of Clouds and Aerosols (MICA); a wind-measuring instrument the Dynamic Atmosphere Mars Observer (DynAMO); and a spectrograph based on the Optical Spectrograph and InfraRed Imaging System (OSIRIS) instrument on the Odin satellite. This paper will discuss the rationale for the mission, the measurements to be made and the scientific progress that can be expected at the completion of the mission.

Keywords: mars, atmosphere, planets

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JMS013 **Oral Presentation** **1140**

Interaction with the solar wind and escape processes on terrestrial planets

Dr. Eric Chassefire
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A major question of comparative planetology today is : how does an Earth-sized planet without global magnetic field interact with the solar wind and why and at which rate does it lose its atmosphere? Mars, due to its small size and the direct interaction of its atmosphere with the solar wind, is thought to undergo significant non-thermal escape, although existing measurements do not provide a fully consistent picture of global escape and its response to solar activity. This could have removed several tens or hundred of millibars of carbon dioxide since the end of the heavy bombardment period, together with the equivalent of a global layer of water several tens or hundred meters deep. Venus, like Mars, does not possess a global magnetic field and its atmosphere directly interact with the solar wind. Although more massive than Mars, Venus could be losing significant amounts of atmosphere to space and as such provide some clues to the potential role of Earths magnetosphere in protecting its atmosphere and hydrosphere from the solar wind. The answer to the question if significant fractions of Mars and Venus atmospheres were lost to space, first by impact, hydrodynamic and sputtering, later by sputtering and thermal escape (as testified on Mars by low atmospheric mass and enhancement of a few heavy isotopes, on Venus by the strong enrichment in deuterium of atmospheric water vapour), is of crucial importance for understanding the origin and evolution of the three terrestrial planets, in a comparative approach. Direct measurements of escape from orbit and in-situ noble gas characterization in the atmospheres of Mars and Venus will play a key role in answeringthe abovementioned key question.

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JMS013 **Oral Presentation** **1141**

Role of Cosmic Dust Analogues in prebiotic chemistry

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Dust grains could have played an important role in driving the formation of complex molecular compounds relevant for the prebiotic chemistry occurred in the early Earth. Dust and molecular compounds present in space experienced very different environments, with temperatures ranging from few to thousands of Kelvins, and with very harsh conditions due to particle and UV irradiations. Astronomical observations of the interstellar medium, coupled with direct in-situ investigations of solar system bodies performed by space missions and laboratory analyses of extraterrestrial material have shown the presence of large amount of organic molecules. The detection of more than one hundred molecules demonstrates that chemical reactions can proceed successfully in space. However, due to low efficiency, formation of complex molecules in gas phase is not feasible, then an active chemistry has been suggested to take place at cryogenic temperatures (~10 K) on cosmic dust grains acting as catalysts. We will present laboratory results on catalytic effects of Cosmic Dust Analogues (CDAs) with olivine composition, on synthesis of organic molecules under different physical conditions by using formamide (NH2COH). We will show the important role of CDAs in prebiotic chemistry experiments simulating processes occurring in astronomical environments relevant for the origin of life in the Solar System.

Keywords: synthesis, catalysis, prebiotic chemistry

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JMS013 **Oral Presentation** **1142**

Thermal Fields in the Venusian Mesosphere as Observed by the VIRTIS-Venus Express Instrument

Dr. Davide Grassi
LESIA Observatoire de Paris

Pierre Drossart, Giuseppe Piccioni, Patrick Irwin, Ludmilla V. Zasova, Nikolay I. Ignatiev, Alberto Adriani, Maria Luisa Moriconi

The VIRTIS instrument on board of Venus Express satellite hosts a spectro-imaging IR channel able to measure the radiance emerging from the Venusian atmosphere in the spectral range 1-5 micrometers with an indicative resolution of 10 nm. Namely, the instrument covers the 4.3 m CO2 band with a S/N adequate to retrieve the T(p) profile with an error < 3K and an effective vertical resolution in the order of 7-10 km in the indicative pressure range 100-0.1 mb (roughly equivalent to an altitude of 65-95 km for an average mid-latitude temperature profile), being the lower boundary actually defined by the unit optical thickness of cloud deck. The VIRTIS imaging capabilities allow therefore to produce stacks of horizontal temperature maps for a given set of pressure levels. This talk provides a preliminary review of the results obtained in the early phases of the mission, focusing on the thermal fields related to the polar dipole observed on the South polar region in the 5 m images. The dipole structure is evident only in the lowest levels probed by the VIRTIS retrievals, being the horizontal temperature gradient maximum at the bottom of our nominal retrieval altitude range. This region is overlaid by a warmer air slab around 30-40 mb, which still presents a local maximum above the pole but no apparent dipolar nature. This induces the occurrence of strong temperature inversions around 50-80 mb (with vertical gradients up to 4k/Km) also polarward of the 'cold collar' region previously detected in Venera 15 FTS data. Higher parts of the atmosphere do not show specific spatial structures and are characterized by an increase of air temperatures at a given pressure level toward the pole, confirming the findings of previous experiments.

Keywords: venus thermosphere, virtis, air temperature retrieval

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JMS013 **Oral Presentation** **1143**

Low-temperature rate constants for neutral reactions of relevance to Titan's atmosphere

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Coralie Berteloite, Andr Canosa, Ian R. Sims

Titan has an atmosphere mainly composed of molecular nitrogen with a notable fraction (a few percents) of methane. Several hydrocarbons have been detected at lower abundances during the various space missions. These compounds are formed by the active photochemistry that occurs in Titan's atmosphere: the photodissotiation of acetylene, C2H2, for instance, a product of methane photolysis, initiates the production of diacetylene, C4H2, the first of the series of polyynes species. Polyynes play a significant role in the chemistry of Titan's atmosphere as they are thought to be precursors to the visible-absorbing haze materials present in many planetary environments 1. Current reaction networks modelling the chemistry involved in the evolution of such environments describe the formation via a polymerization process starting from C2H2 : (C2)nH2 + hn → (C2)nH + H (R1) (C2)nH + (C2)mH2 → (C2)(n+m)H2 + H (R2) There is however, an almost complete lack of quantitative data relating to larger polyynes. In Titan's atmosphere, a complex photochemistry that involves polyynes takes place over a temperature range of 70 - 175 K. The reaction kinetics of the building up of complex long-chain carbon compounds has been studied in various models. Only a very few rate constants, however have been measured under relevant conditions for astrophysical environments, in particular at low temperature 2, the few data available, being limited for reactions of the C2H radical. In these circumstances, the only way for modellers to include these reactions in their chemical scheme is to evaluate their rate coefficients from similar reactions which rates are available in the literature. In this talk will be presented the first ever kinetics study involving C4H radical and the various hydrocarbons detected in Titan's atmosphere. These results were obtained at low temperatures (40 K 300 K) using the CRESU technique 3. CRESU is a French acronym standing for Reaction Kinetics in Uniform Supersonic Flow. Rate constants and their temperature dependence will be presented and compared to the rates used in various photochemical models of Titan's atmosphere. More generally, comparison will be done between rate constants of a series of neutral-neutral reaction estimated in various models and those obtained experimentally in laboratory at low temperature in the last decade. Comments on the way to estimate or extrapolate kinetic data at low temperature will also be done. 1 M. Allen, J. P. Pinto, and Y. L. Yung, Astrophysical Journal 242 (2), L125 (1980); E. H. Wilson and S. K. Atreya, Planetary and Space Science 51, 1017 (2003). 2 I. W. M. Smith, Angewandte Chemie-International Edition 45 (18), 2842 (2006). 3 I. R. Sims, J. L. Queffelec, A. Defrance, C. Rebrion-Rowe, D. Travers, P. Bocherel, B. R. Rowe, and I. W. M. Smith, Journal of Chemical Physics 100 (6), 4229 (1994).

Keywords: atmosphere, kinetics, low temperatures

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JMS013 **Oral Presentation** **1144**

Hydrodynamic escape from planetary atmospheres and its cooling effect

Dr. Feng Tian

James F. Kasting

Atmospheric escape is one important process to determine the evolutionarypaths of planetary atmospheres. During the early stage of planetaryevolution, due to the large solar EUV energy flux of the young Sun,thermal escape probably was the dominant escape mechanisms for lightgases such as hydrogen. If the atmosphere is forced to be in hydrostaticequilibrium, it has been suggested that the exobase temperature of early CO2-dominated terrestrial planetary atmosphere could have reached over10,000 K (Kulikov et al. 2006). Such high exobase temperature should havecaused the upper planetary atmosphere to be in a "blow-off" state -extremely fast escape must occur and the planetary atmosphere may not bedescribed accurately by hydrostatic equilibrium. In addition to this,a planetary atmosphere understrong stellar EUV radiations could have experienced significant cooling effect associated with thefast escape, which has been demonstrated in previous hydrodynamic escapemodels (Watson et al. 1981, Kasting and Pollack 1983, Chassefiere 1996,Tian et al. 2005). In this paper we will use a newly developed multi-component escape model to study the hydrodynamic escape of hydrogen from early terrestrial planetary atmosphere self-consistently. Particularly we will discuss the cooling effect related to the fast escape, estimatethe escape rates of light gases under different solar radiation conditions, and compare the upper atmosphere with that under the hydrostatic equilibrium assumption. Applications of the model to otherplanetary bodies will also be discussed.

Keywords: atmosphere, evolution, escape

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JMS013 **Oral Presentation** **1145**

Effect of aerosol absorption on the transfer of radiation in the near-infrared CO2 band in the atmosphere of Mars

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Dust and water ice aerosols permanently exist in the atmosphere of Mars. The Martian dust is a strong absorber both of the solar and of the thermal radiation and, thus, makes an important influence on the radiative heating, the energy balance and the dynamics of the Martian atmosphere. Till present time there is no full agreement in estimations of the Martian aerosol properties, which are obtained by different methods. So, seeking new independent methods for retrieving the aerosol properties is an actual problem. The aerosol optical depth of the Martian atmosphere can reach considerable values, e.g. at the wavelength of 9 m it varies from less than 0.1 for the condition of transparent atmosphere up to about 5 during global dust storms. Such optical depths are comparable to the ones of the Martian atmosphere in some near-infrared (NIR) bands of CO2, e.g. in the fundamental vibrational transitions of the bands of the CO2 principal isotope with the wavelength shorter than 1.25 m. In the present study the transfer of radiation in the CO2 bands with taking account of the aerosol absorption has been simulated for the daytime Martian atmosphere using an extended non-local thermodynamic equilibrium (NLTE) model. The model involves more than 300 excited states of 7 isotopes of CO2 with vibrational energy up to 9500 cm-1 and about 100000 ro-vibrational lines. The dependence of non-equilibrium populations of high excited CO2 vibrational states on adopted optical depth of aerosol and on its vertical distribution as well as the effect of reflectance properties of the Martian surface on these vibrational state populations have been investigated. A possibility of using the radiation in the NIR CO2 bands for retrieving the aerosol optical depth of the atmosphere of Mars is discussed. The research was supported by the Russian Foundation for Basic Research (grant 07-05-00899a) and by the "Development of scientific potential in higher school" program of Russian Ministry of Education and Science (project 2.1.1.4166).

Keywords: near infrared co2 bands, aerosol absorption, martian atmosphere

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Non-LTE emissions in the upper atmospheres of terrestrial planets

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Giuseppe Piccioni, Miguel-Angel Lopez-Valverde, Angioletta Coradini, Jean-Pierre Bibring

Observations of fluorescent emission of CO2 at the limb of terrestrial planets are documented on Mars, Venus and Earth. These emissions come from low-collisional levels of the atmosphere, when radiative time of the vibration transition in CO2 becomes shorter than collision time. The emission have recently been modelled for Earth, Mars and Venus (e.g. Lopez-Valverde et al. Planet. Space Sci. 2007), and are due to very complex radiative transfer with frequency redistribution in non-LTE regime and optically thick atmosphere, involving a large number of vibration-rotation levels of CO2. Mars observations by OMEGA/Mars Express (Bibring et al., Nature, 2004) provide resolved limb observations of Mars, with peak emission around 90km. Variability of the emission in altitude peak and intensity are observed, and related to atmospheric seasonal variations.On Venu, as observed with VIRTIS/Venus Express (Drossart et al., Planet Space Sci. 2007; Piccioni et al., ESA/SP 1291) a large peak of emission is observed around 120 km, with similar characteristics as on Mars. Due to the higher level of the emission, the fluorescent emission is also well observed in nadir configuration, allowing VIRTIS to search for spatial variability of the emission related to thermospheric density variations at these altitude levels. Finally, Earth observations obtained by Rosetta/VIRTIS in March 2005 have provided limb detection of CO2 emission, very similar to Mars and Venus. Beyond the simple comparison between similar radiative transfer models of the three terrestrial atmospheres, the study of these emission will provide a frame for future investigations in the poorly known field of thermospheric structure and wave activity. Some clues on future works in the field will be presented.

Keywords: planetary atmospheres, space science

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Dynamical phenomena in the Venus atmosphere observed by VIRTIS/VEX

Dr. Giuseppe Piccioni
IASF INAF IAMAS

Drossart Pierre, Lebonnois Sebastien, Sanchez-Lavega Agustin, Hueso Ricardo, Wilson Colin, Tsang Constantin, Adriani Alberto, Moriconi Maria Luisa, Grassi Davide, The Virtis-Venusx Team

VIRTIS is the imaging spectrometer for the ESA mission Venus Express. The Venus Express spacecraft is in orbit around Venus since April 11 2006 and the nominal science mission started on June 2006 and will last about 500 Earth days. First attempts of imaging spectrometry on the Venus night side from space in the near infrared were made by NIMS/Galileo in 1990 and VIMS/Cassini in 1999. The Venus Express mission after about one year of systematic observations of Venus from the spacecraft in orbit gave us and continues to provide a large set of valuable data providing fundamental information to help in solving some puzzle of our mysterious sister planet. Among the scientific objectives of VIRTIS at Venus is the study of the dynamics. This can be achieved by using models starting from the three-dimensional thermal field but the peculiarity of VIRTIS-M, the imaging spectrometer of VIRTIS, allows to measure directly from the clouds tracking by using images acquired at different time, the wind speed at specific altitudes depending on the wavelength and on the day/night side of the planet being observed. The spectral range of VIRTIS-M is 0.25-5mm in two channels with a spectral sampling of about 2nm in the visible and 10nm in the infrared. The spectral range of VIRTIS-H is 2-5mm with a spectral sampling of about 2nm. The spectral windows at 1.74um and 2.3um in the night side probe at an altitude below the clouds layers so that the wind can be directly measured at about 50km height, the region more optically tick for this range. The results show a value of about 50m/s at low latitudes decreasing toward the pole which is consistent with the former observations from the landers. On the day side the reflection of light from the Sun on top of the clouds at about 65-70km height is dominant so that the measured winds correspond to about this altitude and a value as high as 120m/s is measured due to the atmospheric super-rotation and the remarkable vertical wind shear. The rotation period of the dipole, about 2.5 days, is consistent with the measured winds in the polar region. The highest variability in amplitude involving also the direction is observed by tracking the O2 airglow features at a wavelength of 1.27um probing an altitude of about 95km. The most significant results are presented in this talk.

Keywords: virtis, venusexpress, venus

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Laboratory measurements of ion-molecule reactions of relevance for Titan's ionosphere: reactivity of aromatic hydrocarbon ions

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Nives Cont, Pietro Franceschi, Graziano Guella, Giorgina Scarduelli, Paolo Tosi

The ionic chemistry of aromatic hydrocarbons is of interest for the modelling of complex organic molecules in high and low energy environments such as planetary ionospheres, non thermalplasmas and combustion systems. A great research effort is focussed on the modelling of the hydrocarbon rich atmosphereof Titan, which has been recently explored by the Cassini-Huygens space mission. The Ion Neutral MassSpectrometer on board of the Cassini probe has revealed a chemically complex ionosphere dominated by hydrocarbon ion species CnHm+ (with n up to 8 and including C6H5+) and by nitrile species CnNkHm+ [T.E. Cravens et. al. Geophys. Res. Lett. 33, L07105 (2006)]. In this paper we present an experimental and theoretical study of the ionic chemistry of phenylium cations with benzene carried out by using a guided ion beam tandem mass spectrometer to investigate the reactivity as a function of the benzene pressure and of the collision energy. The main ionic products from the reaction of C6H5+ with C6H6 are observed at m/z 155, 154, 153, 129 and 115. Products at m/z 155 correspond to the adduct C12H11+ of phenylium cation with benzene, for which the most plausible structure is protonated biphenyl. Products at m/z 154 and 153 correspond to C12H10+ and C12H9+ ions respectively, coming from the elimination of an H atom or an H2 molecule from the adduct. The channel leading to the production of ions at m/z 129, corresponding to C10H9+ and resulting from the loss of an acetylene molecule by the condensation product C12H11+, may be of particular astrochemical relevance. Theoretical calculations (carried out at the B3LYP/6-31G* level of theory) show that the most stable structure for a C10H9+ species is that of protonated naphthalene, in which case the reaction would be exothermic by 1.27 eV. We have found a possible pathway leading to C10H9+ + C2H2 for which intermediate complexes and transition states are at energies below those of the reactants.In environments where benzene and its ions are present, such a barrierless pathway might be viable for the synthesis of naphthalene, the smallest of PAHs, even at low collision energies. The reaction has also been studied using partial isotopical labelling of reagents in order to look for possible H/D atom scrambling during the reaction. Gaseous arenium ions such as those of benzene and naphtalene are known to undergo statistical H/D scrambling as a consequence of the significant mobility of hydrogen atoms along the aromatic rings [D. Ascenzi et al. J. Chem. Phys. 119, 8366 (2003); J. Chem. Phys. 121, 6782 (2004)]. Our experimental and theoretical results show that inter-ring hopping of H/D atoms is also possible in protonated biphenyl structures leading to a complete randomization of the H and D atoms over both rings.

Keywords: ion molecule, titan ionosphere, aromatic

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JMS013 **Oral Presentation** **1149**

Modeling of the global climate on terrestrial planets

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For about forty years, many institutions and scientific teams around the world have been developping Earth atmosphere numerical weather prediction models (designed to predict the weather a few days in advance) and Global Climate models (design to fully simulate the climate system and its longterm evolution). Such models are now used for a countless numbers of applications, including tracer transport, coupling with the oceans or the geological CO2 cycles, photochemistry, data assimilation to build data derived climate database, etc...Because these models are almost entirely built on physical equations (rather than empiric parameters), several teams have been able to succesfully adapt such models to the other terrestrial planet or satellites that have a solid surface and a thick enough atmosphere. In our solar system, that includes Mars, Venus, Titan, and Triton. On Mars, following the pionneer work of Leovy and Mintz (1969) and Pollack et al. (1981,1990), in the past ten years, several teams around the world have develloped general circulation model of the martian atmosphere and apply these models to various projects. The first application of Mars GCMs has been the prediction of the thermal structure and atmospheric circulation. As on Earth, because the martian atmosphere is also very active and highly variable, they have become essential to analyse and interpret the meteorological observations. Just like on Earth as well,GCMs are now becoming Global Climate model able to simulate the dust cycle, CO2 cycle and water cycle. They are also used as platforms to study the photochemistry of the atmosphere, couple the atmosphere with the thermosphere or the subs-surface, etc... On this basis, GCMs can now be used to predict the climate that could have existed on Mars when the orbital parameters were different ("middle Mars"), or the atmosphere different ("early Mars"). For this purpose, they are becoming more and more useful to help the geologist interpret the enigmatic martian geomorphical and mineralogical observations. Titan is the second extraterretrial body on which GCMs have been succesfully developped and applied to various scientific topics. Teams from France (LMD/SA in paris) and Germany (Koln) have used such models to predict the general circulation and transport and explain the observed distribution of chemical compounds, the structure of the organic hazes and the formation of ethane and methane clouds in the atmosphere of Titan. More recently, in the context of the Venus-Express mission, our team at LMD is developping a new General Circulation Model for the atmosphere of Venus (Lebonnois et al. 2007). This model is the first true Global Climate model combining a3D fluid dynamics solver with the computation of the radiative transferthrough the atmosphere and, in term, the microphysics of the clouds and Venus atmosphere photochemistry. Last, one could mention Triton. Triton's atmosphere is thin (1 to 4 Pa), but that is enough to apply the primitiveequation of meteorology used in General Circulation Models. Such a model was developped at LMD to interpret the observations (plumes, wind streak, thermal structure) gathered by Voyager 2 during its flyby of Neptune in 1989.Using the same kind of numerical tools to simulate climate system that are so different is highly instructive and provides us with truly comparative view of these atmospheres.

Keywords: atmosphere, modeling, planets

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JMS013 **Oral Presentation** **1150**

Gas-phase neutral-neutral reactions in planetary atmospheres

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A thorough characterization of the chemical evolution of planetary atmospheres can provide useful insights into their origin and the birth of our solar system. Such a characterization relies on a multi-disciplinary approach: 1) observations allow us to identify the molecules and their number densities as they are nowadays; 2) the chemistry which lies behind their formation starting from atoms and simple molecules is accounted for by complex reaction networks; 3) for a realistic modeling of such networks, a number of experimental parameters are needed and, therefore, the relevant molecular processes should be fully characterized in laboratory experiments. Similarly to the atmosphere of Earth, the atmospheres of the other planets (or satellites, like Titan) can be described as giant photo-reactors, where the energy deposited mainly by solar photons, but also by cosmic rays and other energetic particles, drives a complex gas-phase chemistry. In this context, gas-phase neutral-neutral reactions are expected to play a dominant role and, therefore, an important contribution in their characterization is given by photochemistry and chemical kinetics. A survey of the available literature reveals, however, that much information is still lacking if it is true that only a small percentage of the elementary reactions considered in the models have been characterized in laboratory experiments. For this reason, several research groups have undertaken specific research programs aimed at investigating those elementary reactions. Special mention goes to the sophisticated CRESU (Cintique de Raction en Ecoulement Supersonique Uniforme) gas-kinetic technique, the development of which has made it possible to investigate elementary reactions at very low temperatures, as those characterizing some interesting atmospheres like that of Titan. Reaction kinetics studies provide us with the reaction rate constants, but, more rarely, are able to determine the nature of the products and their branching ratios. However, since the products of one reaction are going to be the reagents of a subsequent one, it is quite relevant to include the correct product branching ratios for each reaction considered in the models. To address this issue, a complementary and powerful approach is the crossed molecular beam (CMB) technique with mass spectrometric (MS) detection. This technique, widely used in the chemical physics community to address fundamental aspects of reactive processes, has more recently been extended to the study of the elementary reactions of interest in the chemistry of planetary atmospheres. In all cases investigated it has been possible to characterize (a) the nature of the primary reaction products, with some surprise with respect to the expected results (b) the branching ratios of competing reaction channels, (c) the microscopic reaction mechanisms and (d) the product energy partitioning, which can strongly influence the destiny of the reaction products. The case of some elementary reactions and their effect in the models will be illustrated and possible extension to other systems discussed.

Keywords: planetary atmospheres, laboratory experiments, gas phase reactions

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Observations of the atmospheric water on Mars with the OMEGA experiment onboard Mars Express

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The OMEGA mapping spectrometer onboard the ESA Mars Express orbiter combines high spatial resolution (~ 300 m at periapsis) with high S/N ratio (> 100 over the whole spectral range), and thus it's well-suited to study at an unprecedented detail the behavior of water vapor in the Martian atmosphere in specific regions of interest as well as at a global scale. The OMEGA data set covers more than one Martian year observed at a wide range of solar local times, between early morning and late afternoon. We retrieved the water vapor abundance from OMEGA data using the 2.6 m band, which is the most sensitive and 3 - 5 times stronger than the other water bands in the OMEGA spectral range, and it's expected to be free of mineralogical features. We will present our results of the seasonal and diurnal trend of water vapor both at a global and at a mesoscale level. In this last case we will focus mainly on the most peculiar and interesting regions of the planet, as the Tharsis plateau, the Hellas basin, and the Valles Marineris canyon. Our results show a global seasonal behavior which is in good agreement with the results from MAWD/Viking (Jakosky & Farmer 1982, Fedorova et al. 2004) and TES/MGS (Smith 2002). The maximum of water vapor abundance, around 80 - 90 precipitable m, at high northern latitudes during the early northern summer, due to the sublimation of the seasonal polar cap, is evident. The asymmetry of the behavior between the two emispheres is also well reproduced. The detailed retrieval over interesting regions of Mars' surface marks instead the importance of local phenomena for the water cycle. For instance, the atmosphere over the Tharsis volcanoes is peculiary enriched in water vapor, compared to their surroundings. This behavior can be explained only if we take into account the influence of the local circulation generated by the extreme topography of the region.

Keywords: mars, atmosphere, water

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JMS013 **Oral Presentation** **1152**

Radiation in the atmospheres of terrestrial planets

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Fredric W. Taylor, David Crisp, Mark A. Bullock, Nilton O. Renno

Radiation plays an important role in various processes on the planets. It determines temperature structure, controls photochemistry, forces atmospheric motions. Radiation is also the main carrier of information about the planetary atmospheres and surfaces that is being widely used in remote sensing.Observations, numerical modeling and theoretical studies have all revealed the extremely important role that radiation plays in various processes on Venus, both now and early in its history. The large opacity of the atmosphere and the presence of great amounts of radiatively active gases and aerosols give Venus its unique place among the terrestrial planets. The greenhouse mechanism has clearly been very effective in forming the current and early climate on Venus, while the peculiar distribution of the radiative energy sinks and sources drives the remarkable super-rotation of the entire atmosphere. Chemical interactions between different gaseous and aerosol species and the importance of non-linear feedbacks make the Venus climate a very complex system.Previous investigations of radiation in the Venus atmosphere provided a general understanding of the distribution of fluxes, sources and sinks of radiative energy, and of the radiative forcing of the atmospheric dynamics and climate. At the same time they left a great number of unsolved problems. One of the most important open issues in this field is the variability of atmospheric properties such as the abundance of radiatively active gases, cloud microphysical and optical properties and total opacity, and the influence of these on the energy balance. The second problem concerns the radiative forcing of the atmospheric global circulation. How does the distribution of the sources and sinks of radiative energy drive the atmospheric dynamics? The thermodynamics of the Venus atmosphere is the third issue needing to be clarified and quantified. New studies of the fluxes and balance of energy and entropy, the role of dissipative processes and efficiency of the Venus heat engine will help us to understand the Venus climate-forming mechanisms. The forth open question concerns the role of radiation in the evolution of the Venus atmosphere, the early greenhouse effect and the loss of water from the planet, as well as recent climate perturbations during global resurfacing. Resolving these open issues in Venus physics would result in significant progress in comparative planetology and climatology of the terrestrial planets in general and in the study of the Earths climate evolution in particular. This paper will give an overview of our current knowledge about the radiation field in the Venus atmosphere, role of the radiation on the atmospheric dynamics, current climate and its evolution. It will also compare the radiative effects on terrestrial planets.

Keywords: radiation, climate, dynamics

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JMS013 **Oral Presentation** **1153**

Venus Express - Results of the first year in orbit

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ICPAE ESAESTEC IAMAS

After a launch from the Baikonur cosmodrome, Kazakhstan, 9 November 2005 and afive-month cruise, the Venus Express spacecraft reached Venus on 11 April 2006. The spacecraft reached its final operational, 24 hour polar orbit on 5 May 2006. During the first year in operation the spacecraft has sent back a wealth of new and exiting information. The objective of the Venus Express mission is to carry out a comprehensive study of the atmosphere of Venus, the plasma environment and its interaction with the solar wind, and to study certain aspects of the surface of the planet. A well optimised payload composed of two multi channel spectrometers, an IR-Vis-UV imaging spectrometer, a wide angle camera, a multi-sensor energetic particle instrument, a magnetometer, and a radio science experiment, allows all elements of the objectives to be addressed at a sufficient depth. Venus Express has been developed in record time, less than four years, using an efficient concept of re-using elements of recently developed spacecraft, mainly Mars Express and Rosetta. The first data has shown a highly dynamic atmosphere, including close-ups of the southern polar double vortex, indeed topics of high interest and among the top priority objectives. The high resolution spectrometers are finding several minor species at various depths of the atmosphere, including D/H ratios as function of altitude. Venus Express is the first mission fully exploiting the Infrared spectral windows, in order to map the atmosphere in three dimensions. The data returned from the mission during the first year is of extraordinary quality and has already led to new insights in several fields. This talk will summarize the the major findings and report on the status of the spacecraft and the plans for the future activities.

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JMS013 **Oral Presentation** **1154**

Towards the Formation of PAHs in Titans Atmosphere

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The key objectives of our research program are to understand the formation and growth mechanisms of unsaturated hydrocarbon molecules such as polycyclic aromatic hydrocarbons (PAHs) together with their hydrogen deficient precursors from the bottom up in the atmosphere of Saturns moon Titan. The implications to the hydrocarbon chemistry of Titan's atmosphere offer extraordinary opportunities for understanding the origin and chemical evolution of the Solar System. To achieve these objectives, we utilize a crossed beams machine to investigate the collision energy dependent dynamics of reactions leading to hydrocarbon growth under single collision conditions. These provide information on the reaction product(s), their branching ratios, and the intermediates involved. The results also yield insight into elementary mechanisms of the reactions of radicals with unsaturated hydrocarbons a reaction class strongly believed to be the key step in the formation and growth of hydrocarbon molecules in Titans atmosphere. This talk reviews first the formation of highly unsaturated nitriles, i.e. organic molecules holding the CN group, via reaction of cyano radicals, CN, with unsaturated hydrocarbons. Hereafter, we present new data on the reactions of phenyl (C6H5) radicals with unsaturated hydrocarbons acetylene, ethylene, methylacetylene, and allene prototype reactants and representatives of simplest alkynes, alkenes, and cumulenes together with their isomers. The similarities and distinct differences between CN and C6H5 radical reactions with unsaturated hydrocarbon molecules are discussed; generalized trends on the mechanisms, intermediates, existence/absence of entrance barriers, and reaction energies together with the implications to thermal and non-equilibrium chemistry in Titans atmosphere are presented, too. Also, an outlook for further studies of ethynyl radical reactions is given.

Keywords: titan, pahs, hydrocarbons

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JMS013 **Oral Presentation** **1155**

Vortex Circulations on Venus and Earth

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Vortex organization of the Venus atmosphere was first detected from Mariner 10 ultraviolet image data acquired in 1974. This organization was subsequently seen from Pioneer Venus ultraviolet images obtained during 1978 1983. Venus Express mission has now provided us with views of the vortex circulation on Venus (south hemisphere) from the VIRTIS (night side and the day side) and the VMC (day side) and shown that the vortex extends deep below the ultraviolet clouds. To these similarities between the circulation of a hurricane or a tropical cyclone and that of the two hemispheric vortices on Venus discussed by Suomi and Limaye (Science, Vol. 201, p. 1009-1011, 1978), we can now add the existence of whorls in the core region as well, despite at least an order of magnitude difference in physical scale. Whorls or swirls seen within many tropical cyclones arise due to dynamical instability (Kossin, J.P., B.D. McNoldy, and W. H. Schubert, Month. Wea. Rev., 130, 3144-3149, 2002) and it is possible that the same may be true on Venus in the core region of the hemispheric vortices. The life times of tropical storms on Earth are typically weeks. The vortex circulation on Venus has now been observed over more than three decades. It likely is a permanent feature of the Venus atmosphere. The long term stability of this circulation and the dynamical processes that it exhibits or is subject to may be related to the processes that maintain the atmospheric superrotation and the physical properties of the atmospheric environment on Venus.

Keywords: venus, vortex, circulation

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Kuiper Belt objects and comets: links and thermal evolution

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It is believed that the KBO region contains primitive bodies, inside which pristine material can be preserved. These bodies could be remnants of the solar system formation. However, the observations show very different superficial characteristics, that are possibly related to the original composition, or, to their further evolution. Here we will try to follow the evolution of large and intermediate bodies in presence of short lived radioactive elements. We will also consider the effect of low-sublimation- point ices.We will follow also the complex internal evolution of these objects, depending on the choice of different relevant parameters, such as the presence of ammonia and other anti-freezing salts. We will try to see the bodies so-obtained could be the parent bodies and if it is possible, notwithstanding the thermal evolution, to still give origin to comets.

Keywords: kbo, comets

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JMS013 **Oral Presentation** **1157**

Coupled Climate/Surface/Interior Evolution of Venus

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Venus is commonly thought to have experienced a transition, early in its history, from a wet, more Earth-like past to its current highly desiccated state (Kasting, 1988). A more recent global transition is revealed by the sparse, randomly distributed and relatively pristine crater population, which indicates a rapid decrease in resurfacing rate between 300 and 1000 Myr ago (Schaber et al, 1992; Bullock et al, 1993; McKinnon et al, 1997). The accompanying precipitous decline in outgassing rate would have caused large climate changes (Bullock and Grinspoon, 2001) and globally synchronous plains deformation (Solomon et al, 1999). We are exploring the possibility that these two transitions may be part of a single planetary transformation. The loss of atmospheric water through evaporation, photodissociation and H escape would have eventually led to a transition from plate tectonics to single plate behavior, as the shut-off of subducting hydrated sediments led to the desiccation of the mantle and consequent loss of an asthenosphere. Current estimates of the timescale for water loss are highly unconstrained, with error estimates larger than the age of the planet. Currently, we are modeling clouds in wet, hot atmospheres in an effort to better constrain the albedo, energy balance and timescale for water loss. If clouds stabilized the moist greenhouse and Venus oceans persisted for several billion years, rather than the canonical (but unconstrained) hundreds of millions, then the loss of water could have initiated changes in global convective style which led directly to the currently observed surface features. This might mean that Venus was a (conventionally defined) habitable planet for most of its history.

Keywords: venus, climate, atmosphere planetary

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JMS013 **Oral Presentation** **1158**

The Present Climate of Venus

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The structure and behaviour of the atmosphere of Venus is curiously at odds with that of the Earth despite many common aspects of composition and evolution. The Venus Express spacecraft now orbiting Venus is about one year into its mission, which ends in 2009, to explore the atmosphere and climate of our nearest planetary neighbour. In this talk we discuss what has been learned so far, and prospects for addressing remaining mysteries with the data still to be accumulated

Keywords: venus, atmosphere, climate

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JMS013 **Oral Presentation** **1159**

Laboratory measurements of spectral properties of atmospheric gases

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The spectroscopic study of gases present in planetary atmospheres encounters two fundamental problems. The first is due to the fact that pressures and temperatures are often much different from those on earth and sometimes difficult to obtain in laboratory experiments. The second problem is that the main interest is focused on the so-called atmospheric windows, which implies very weak absorptions of the main constituents combined with long absorption paths. In a laboratory experiment absorption paths of 200-300 meters can be achieved by using multipass set-ups, often in combination with Fourier Transform Spectrometers. Effective paths of several km can be obtained by using the cavity ring down technique, which is based on optical cavities equipped with high reflectance mirrors coupled with narrow band lasers. Here a survey is presented of experimental work on the most important atmospheric gases on Venus and Titan.

Keywords: spectroscopy, line broadening

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JMS013 **Oral Presentation** **1160**

Structure and composition of the Venus upper atmosphere from the SPICAV/SOIR/ Venus Express observations.

Dr. Jean-Loup Bertaux

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SPICAV (SPectroscopy for the Investigation of the Characteristics of the Atmosphere of Venus) is a suite of three spectrometers in the UV and IR range with a total mass of 12.3 kg flying on Venus Express orbiter, dedicated to the study of the atmosphere of Venus from ground level to the outermost hydrogen corona at more than 40,000 km. The UV spectrometer (118 - 320 nm, resolution 1.5nm) has detected on the night side, the g and d bands of NO. In the stellar occultation mode the UV sensor is mainly measuring the vertical profiles of CO2, temperature, clouds and aerosols (80-140 km, covering the mesosphere and lower thermosphere. So far, star occultations on the night side indicates the existence of a hot layer of air at the mesopause which had escape detection before. This is interpreted as the adiabatic descent of air in the Solar anti-solar (SS-AS) circulation system present in thermosphere, on the night side. The UV aerosol horizontal opacity is 1 at 90 km altitude, with a haze extending up to 104 km. The SPICAV VIS-IR sensor (0.7-1.7 mm, resolution 0.5-1.2 nm) employs a pioneering technology:acousto-optical tunable filter (AOTF). On the night side, it measures the thermal emission peeping through the clouds. In solar occultation mode this channel permits to study the vertical structure of H2O, CO2, and aerosols, allowing to characterize their size distribution. The SOIR spectrometer is a new Solar Occultation IR spectrometer in the range l=2.2-4.3 µm, with a spectral resolution l/Dl>15,000, the highest on board Venus Express (VEX). This new concept includes a combination of an echelle grating and an AOTF crystal to sort out one order at a time. A number of solar occultations were performed in various wavelength domaines, allowing the measurement of HDO, H2O, HCl, HF, CO and CO2 vertical profiles. The abundance of HCl is about 3 times less than previously reported for 1966 and 1986 similar observations, while the HF mixing ratio is found variable with altitude. From all these vertical profiles emerges a picture where the SS-AS circulation system (affecting the thermosphere) do interact strongly with the super-rotation system (visible in the troposphere) in the mesosphere. The vertical profiles variations may be interpreted as belonging to air masses of different origins, which happen to be located at the same point at the time of the occultation. They most likely do not indicate 1-D vertical transport.

Keywords: venus, atmosphere, composition

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JMS013 **Oral Presentation** **1161**

Cassini Radio Science Observations of Titan's ionosphere

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Jet Propulsion Laboratory California Institute of TechnpologyL IAGA

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We report results on Titan's ionosphere from the Cassini radio occultations of March 26, and May28, 2007 (T27 and T31), as well as those of March 19, 2006 (T12), and May 20,2006 (T14) . The 2006 occultations occurred at low Southern latitudes of 14.7S, 36.2S, 19.8S, and 21.9S. The 2007 occultations were nearly polar, at latitudes of 75S and 61N for T27. and 75S and 74N for T31.. The solar zenith angles for all occultations were near the terminator, ranging from 85 to 95 deg.The ionosphere peak was observed to lie close to an altitude of 1200 km, and the observed peak densities ranged from about 1.2 to 2.0 x 103 cm-3, which is in good agreement with other Cassini observations and the previous Voyager radio occultation results. In all measurements, the peak densities are about 30% higher near the dusk terminator, showing the influence of solar EUV.Radio occultation observations of the Titan ionosphere are difficult because of its low density and small size, and it was facilitated by the unprecedented Cassini radio science system, which has three frequencies that can operate simultaneously: S-band (2.3 GHz), X-band (8.4 GHz), and Ka-band (32 GHz). In particular, Ka-band had never been used before to probe Titan's ionosphere, and the signal-to-noise ratios at all frequencies of 42, 54, and 48 dB-Hz., respectively, have never before been achieved.

Keywords: ionosphere of titan, cassini radio science

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JMS013 **Poster presentation** **1162**

Variations of elastic energy of Luni-Solar tides and repeatability and inversion of forms of atmospheric circulations

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The correlations of variations of elastic energy of luni-solar tides of the Earth with cyclic changes of latitudinal and longitudinal atmospheric circulations have been studied: W is the circulation of zonal type for which in the bottom and average troposphere of the Atlantic-European sector the western quasi-zonal stream with waves of small amplitude exists; C is the meridian type of circulation at which the high-altitude crest is located above the east of Atlantic and the Western Europe and a high-altitude hollow is above East European plain; E is other type of the meridian circulation at which above East Atlantic and Western Siberia the deep hollow is established, and above East European plain is observed a high crest. Cyclic regular changes and change of activity of forms of atmospheric circulation (their repeatability) are observed. So during last hundred years repeatability such as circulation of C type changed approximately with rhythm in 30 years. The frequency of occurrence of types of circulation W decreased, and for forms E the frequency was increased. In the last decade the situation has taken place - the repeatability of events W has increased, and of forms E has decreased (Evseeva, 2002). The long-periodic and decade variations and inversion in activity of circulation E and C types are observed. At increasing of repeatability of form E there is a decrease approximately in the same rate of repeatability of form C. And peak values of repeatability of both types of circulation have place approximately for the same dates. A similar inversion is observed and for the third type of circulation W with the E type. The basic phenomenon which here is discussed, is a correlation of dates of peak values of variations of repeatability of types of circulation to dates of extreme values of envelope of the curve of elastic energy of the Earth luni-solar tides (in first with period of 4.45 yr). The elastic energy was calculated under analytical formulas at the strict account of particularities of orbital motions of the Moon and the Sun. On the other hand due to the differential gravitational action of the Moon and the Sun on the Earth shells the core tests small oscillations relatively to elastic mantle. Thus the atmosphere is perturbated directly by mentioned celestial bodies, and also by additional influences from the party of cyclically displaced superfluous mass of the core. The atmosphere and its behaviour are rather sensitive to displacements of the core. For example, it is observed rhythmical change of atmospheric masses between northern and southern hemispheres not only with the annual period, but also with the monthly periods. In the future interannual and decade changes of atmospheric masses between opposite hemispheres of the Earth will be observed (the periods of expected variations are 2.1, 3.6, 4.5, 6, 9.3, 18.6 (in years) etc. Thus, the atmospheric circulation is dynamically connected to gravitational influences of the Moon and the Sun both directly on the atmosphere, and on other shells of the Earth (first of all on the core and the mantle). Small relative displacements of the core and the mantle cause atmospheric tides of an inversion type, and cause also the latitudinal and longitudinal redistributions of masses in the certain rhythms and at the change of types of circulation. References Barkin, Yu.V., Ferrandiz, J.M. (2004) Tidal elastic energy in planetary systems and its dynamic role. Astronomical and Astrophysical Transactions, v. 23, Issue 4 (August 2004), pp. 369-384. 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. Kislov A.V. (2006) Changes of a climate outside of tropical latitudes. In the book: Modern global changes of the natural environment. In two volumes (Eds. N.S.Kasimov, R.K.Klige). Publisher "Scientific world" T.1. p. 175-184. Evseeva L.S. (2002) Long-term variations of circulation of atmosphere. The atlas of temporal variations of natural, anthropogenous and social processes. T.3. M.: Publisher "Scientific world".

Keywords: atmosphere, circulations, variations

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS013 **Poster presentation** **1163**

Oxygen chemistry and the stability of CO2 in Venus' middle atmosphere

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A key question in photochemical studies of the Venusian atmosphere has been (and is) what chemical mechanism(s) stabilize its primary constituent (CO2) against ultraviolet (UV) radiation. CO2 photodissociates on the day side into CO and O after absobing photons at ~< 200 m. At the altitudes where photodissociation of CO2 occurs, the reaction 2O + M > O2 + M is highly favored over CO + O + M > CO2 + M, where M is any third molecule or atom that can collisionally stabilize the O2 and CO2 that are formed in these reactions. Observations of intense airglow, produced as oxygen molecules in the electronically excited O2(a) and O2(c) states decay radiatively to the ground state, confirm rapid production of O2 on both day and night sides. Achieving an appropriate balance in numerical models between this rapid production of O2 and the rapid destruction implied by the observational upper limit on ground-state O2 has been a challenge for the past 25 years. The results from a new examination of the CO2 photodissociation cross sections measured in laboratories from 1983 to 2006 will be presented along with the results from numerical simulations of several potential chemical mechanisms for both increasing the rate of production of CO2 and the rate of destruction of O2 in Venus' middle atmosphere.

Keywords: venus, atmosphere, chemistry

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JMS013 **Poster presentation** **1164**

The weakly bound complexes of acetylene with rare gases and hydrogen molecule: molecular-beam scattering and pressure broadening cross section experiments

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Acetylene is a trace constituent of the Earths atmosphere, mainly produced by anthropogenic sources [1], and has also been detected in the atmosphere of the giant planets (Jupiter, Saturn, Uranus and Neptune) [2,3], and Titan [4]. Photolysis of methane by solar radiation yields various product hydrocarbons of which the most abundant are ethane and acetylene [5]. In 2004, Mars Express confirmed the presence of methane in the Martian atmosphere where various rare gases are also present. Moreover, acetylene is involved in many processes relevant to combustion and the simplicity of its spectra is well suited for thermometry applications using vibrational or rotational coherent anti-Stokes Raman scattering (CARS). For all the above applications, a detailed knowledge of collisional line broadening of acetylene is required. For the above reasons we started this study with the prototype acetylene-rare gas weakly bound systems. The latters have been extensively investigated in recent years. As pointed out in most of the literature papers the interest for these systems stems from the presence of the triple carbon-carbon bond which make acetylene a sort of prototype apolar anisotropic molecule and its complexes with rare gases worth to be studied. Integral cross sections and pressure broadening coefficients have been measured in the lab for the acetylene RG (RG= Ne. Ar, Kr and Xe) systems by a molecular beam scattering technique and high infrared resolution spectroscopy respectively. In order to analyze the data we derived semi-empirical PES parameterized using an atom-bond pairwise additive scheme. The PESs have been optimized on the experimental scattering cross sections and then used to calculate the pressure broadening coefficients for all the systems [6-8]. A good agreement has been found. Very recently we have extended the study to the even more interesting case of the C2H2-H2 complex.References [1] A. Goldman, F.J. Murcray, et al. J. Geophys. Res., 86 (1981) 12143.[2] Th. Encrenaz, P. Drossart, et al., Planetary and Space Science, 47 (1999) 1225 (1999).[3] P.V. Sada, G.L. Bjoraker, et al., Icarus, 173 (2005) 499.[4] R. Lorenz , J. Phys. IV France, 12 (2002) 281.[5] R. Hanel, B. Conrath, et al., Science, 212 (1981) 192.[6] D. Cappelletti, M. Bartolomei, et al., J. Phys. Chem. A, 109 (2005) 8471.[7] D. Cappelletti, M. Bartolomei, et al., J. Chem.Phys., 126, 064311 (2007).[8] F. Thibault, D. Cappelletti, et al., to be submitted (2007)

Keywords: acetylene, collisional line broadening, molecular beam scattering

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS013 **Poster presentation** **1165**

Hydrogen Collisions in Planetary Atmospheres, Ionospheres, and Magnetospheres

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Molecular hydrogen is the dominant chemical species in the atmospheres of the giant planets. Because of their low masses, neutral and ionized hydrogen atoms are the dominant species in the high atmospheres of many planets. Finally, protons are the principal heavy component of the solar wind. Here we present a critical evaluation of the current state of understanding of the chemical reaction rates and collision cross sections for several important collision processes in planetary atmospheres, ionospheres, and magnetospheres. These processes are grouped as follows: (a) H2(v,J) + H2 vibrational, rotational, and ortho-para relaxation, (b) H+ + H2(v) ion-molecule reactions, and (c) charge transfer in collisions of H+ with H. Of particular importance are the conclusions that H2 ortho-para conversion is at least an order-of-magnitude faster than previously assumed and that H+ + H2(v) is more likely to result in vibrational relaxation than charge transfer.

Keywords: critical evaluation, collision cross sections, chemical reaction rates

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JMS013 **Poster presentation** **1166**

The expansion of dust in the region of the Hellas Basin

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The behavior of dust in the region of the Hellas Basin is investigated using GCM modified for Martian environment. The model is based on Dennou-AGCM5.3 (SWAMP Pro. 1998, http://dennou-k.gfd-dennou.org/arch/agcm5/index.html, in Japanese). The basic equations of the model is three dimensional primitive equations on a sphere with sigma coordinate. The horizontal resolution is about 2.8 deg longitude by 2.8 deg latitude (the triangular truncation with wavenumber 42). The domein has 23 sigma layers in the vertical with higher resolution near the surface. The season in the model is Ls=180 (the southern spring equinox). The features of the expansion of dust in and around the Hellas Basin are investigated by comparing processes of the expansion of dust injected from the different dust sources in the model. The 10 dust sources are located in the region of the Hellas Basin, 4 of which are located inside the Hellas Basin, 4 of which are located on the north to the basin (outside the Hellas Basin) and 2 of which are located on the south to the basin (outside the Hellas Basin). Dust inside the Hellas Basin does not tend to expand outside the basin and moves cyclonically inside the basin. It is possible that the precursory activity of local dust storms which grow into 2001 global dust storm is partly associated with the cyclonic vortex. Estimations of the vertical flow of the vortex and the depth of convective mixing layer shows that dust cannot expand outside the Hellas Basin whose the depth is about 8 km. In contrast, dust in the low latitudes tends to expand eastward by westerly wind (Lewis and Read 2003). dust located on the north just to the Hellas Basin is transported by upward slope wind on the northern slope of the Hellas Basin and expands eastward. These behaviors of dust in and around the Hellas Basin are consistent with the precursory dust activity and the expansion phase of 2001 global dust storm. In the presentation, the processes of dust expansion or localization for 2001 global dust storm and the involved local dust storms will be considered.

Keywords: mars, meteorology, dust storm

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JMS013 **Poster presentation** **1167**

Superrotation of the Venus atmosphere simulated by an atmospheric general circulation model

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Rapid zonal flow with a velocity near 100 m s1 has been observed at the cloud top on Venus. The speed of the zonal flow at the cloud top is 60 times faster than that of the solid surface. The fast zonal flow prevails from the surface to the cloud top, where the zonal wind speed reaches the maximum. This phenomenon, known as superrotation, is a dynamical problem of the Venus atmosphere. Several mechanisms that might maintain the superrotation have been proposed, but the true mechanism is still unclear. In this study, the mechanism of the superrotation in the Venus atmosphere is investigated by an atmospheric general circulation model. The model used in this study is based on the atmospheric general circulation model (AGCM) version 5.7b developed at the Center for Climate System Research/National Institute for Environmental Study/Frontier Research Center for Global Change (CCSR/NIES/FRCGC). We have developed a new Venus AGCM, in which radiative transfer is calculated, and tried to reproduce the superrotation under the realistic condition. The vertical structure of temperature below 70 km is well reproduced in the model. Longitudinally averaged zonal wind is about 70 m s1 at the equatorial cloud top. Mean zonal flow in the equatorial cloud layer is maintained primarily by momentum transports related to thermal tides and momentum advection by the mean meridional circulation. Below 55 km, the zonal wind is less than 5 m s1 and very weak compared with observations. Although the superrotational flow of about 70 m s1 is developed by thermal tides in the middle atmosphere, the superrotational flow cannot be reproduced in the lower atmosphere. We assume that small-scale gravity waves which are not resolved in the model are important for the maintenance of the superrotation in the lower atmosphere. The momentum flux of the small scale gravity waves is estimated by parameterization. The superrotation simulated in the experiment with the gravity wave parameterization is consistent with observations. Zonal flow increases with height from the surface to the cloud top, where the zonal wind speed reaches about 100 m s1. Forced gravity waves with westerly phase speed are absorbed at the critical levels and accelerate the westerly mean zonal flow. On the other hands, the forced easterly waves have no critical levels and can propagate above the cloud layer. Above the cloud layer, they are dissipated by thermal damping. Forced easterly waves play an important role in vertical wind shear in the upper atmosphere. In this study, we succeed in simulating the superrotation in a realistic Venus AGCM and provide a new promising mechanism. The momentum transport due to small-scale gravity waves is essential to maintain the superrotation in the lower atmosphere.

Keywords: general circulation, thermal tides, gravity wave

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JMS013 **Poster presentation** **1168**

A numerical simulation of lower Venus atmosphere.

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Superrotation of Venus atmosphere is mysterious phenomena (i.e. cloud layer rotates 60 times faster than ground). Many theories about its generating mechanism have been proposed in the past, but observations and simulations are not enough to support them. Recently, many Venus-like AGCMs (atmospheric general circulation models)have tried to simulate Venus atmosphere. However, most of them are not successful to generate superrotation in lower atmosphere. In the present study, superrotation in lower Venus atmosphere issimulated by a simple dynamical core AGCM (T21, $0<z<40$km) with simple grey-atmosphere radiation. For some condition, superrotation with sufficient strength is generatedin lower levels by the mechanism proposed by Gierash(1975). Details will be shown at the meeting.

Keywords: venus, superrotation

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JMS013 **Poster presentation** **1169**

Laboratory studies on neutral-neutral gas-phase reactions of O, C, and N atoms with organic and inorganic molecules of relevance in the chemistry of planetary atmospheres

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Nadia Balucani, Kevin H. Hickson, Enrico Segoloni, Piergiorgio Casavecchia

A variety of molecular species have been identified in the atmospheres of solar planets and satellites. Amongst the different types of processes which are believed to be involved in their formation, neutral-neutral gas-phase reactions are alleged to play an important role. In our laboratory we have used the crossed molecular beam (CMB) technique with mass spectrometric (MS) detection to investigate elementary reactions of relevance in the chemistry of planetary atmospheres for a number of years. The main advantage of CMB experiments is that it is possible to observe the consequences of well defined molecular collisions and avoid the effects of secondary or wall collisions. The quantities observable by this experimental technique allow us to achieve the most detailed characterization of a reaction and to derive important features, such as the product branching ratios. In this respect, the coupling of the CMB technique with MS detection is crucial, because every product can be ionized in the ionizer which precedes the mass filter. However, a limit of the CMB/MS method has been caused by the dissociative ionization of interfering species, which can make it difficult to investigate multichannel polyatomic reactions, as are many reactions of interest in the chemistry of planetary atmospheres. To reduce this problem, we have implemented - for the first time in CMB experiments - the technique of soft ionization by tunable low-energy electrons. Such a novel approach in CMB experiments has shown to be of success in characterizing all the reactive channels of multi-channel reactive systems. Another improvement recently achieved in our laboratory has been the set-up of a variable beam crossing angle configuration which allows varying the experimental collision energy over a much wider range than previously possible. In this contribution we report recent experimental results on some reactions of relevance in the chemical evolution of planetary atmospheres involving atomic species such as O, C, and N.

Keywords: planetary atmospheres, neutral neutral reactions, laboratory studies

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JMS013 **Poster presentation** **1170**

Experimental investigation of neutral-neutral gas-phase reactions involving simple radicals (CN, OH, CH3 and C2) of relevance in the chemistry of planetary atmospheres

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Simple radicals have been recognized in a variety of extraterrestrial environments, and the reactions involving them are supposed to play an important role in the formation of several polyatomic species present in the atmospheres of solar planets and satellites. Neutral-neutral elementary reactions between simple radicals and molecular species have been studied for some years in our laboratory by means of the crossed molecular beam (CMB) technique with mass spectrometric (MS) detection. The CMB technique allows one to study a well defined reactive event in single-collision conditions, i.e. avoiding interferences from secondary reactive and/or non-reactive processes. MS detection can be applied, in principle, to every species, so that the possible primary products of the reaction can be identified and, in the case of multichannel reactions, the branching ratios can be derived. The quantities observable by this experimental technique allow us to achieve the most detailed characterization of a reaction and provides important information (for instance, the energy content of the produced particles). A limitation of the method could reside in the scarce availability of reactant radical beams, because of the difficulty to generate such unstable species with an intensity high enough to perform a scattering experiment. In our laboratory we have been able to produce a large variety of beams of atomic and polyatomic radicals by means of a radiofrequency discharge and a flash-pyrolytic beam sources: this capability, combined with the universality of the mass-spectrometric detection method, has made us able to study a variety of radical-molecule and radical-radical reactions of interest in the chemistry of planetary atmospheres, such as those involving CN, OH,CH3 andC2 radicals.

Keywords: planetary atmospheres, neutral neutral reactions, laboratory experiments

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JMS014 **1171 - 1201**

Symposium
Ocean-Atmosphere Coupling

Convener : Dr. David Woolf
Co-Convener : Dr. De-Zheng Sun

The ocean and atmosphere are coupled through air-sea fluxes of heat, mass, momentum, and biogeochemical species. This symposium examines the mechanisms and feedbacks that couple the atmosphere and ocean, in particular, the dynamics, thermodynamics, and biogeochemical cycling of the coupled atmosphere-ocean system at latitudes from the equator to the poles

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JMS014 **Oral Presentation** **1171**

Ocean-atmosphere coupling generating large-scale convection polarity across Atlantic Ocean

Dr. Abebe Yeshanew
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Modes of Subsurface thermocline up to 300 meter depth over tropical oceans are investigated based on 1950-1999 on monthly timescale using singular value decomposition (SVD). The leading spatial mode unravels a giant dipole in the equatorial Pacific Ocean underneath. This equatorial Pacific global wave generates a polarity in velocity potential in the upper atmosphere and convection on either side of Atlantic Ocean over the terrestrial body. The polarities over tropical Africa and South America are center of action for east-west circulation Pacific Walker and Atlantic Zonal Circulations. Following same procedure, modes of variability equatorial Atlantic subsurface temperature are analysis. SVD unravel a positive single mode east of 300W with maximum value in coast of West Africa within 0-100 meters depth. The temporal mode is interplayed with zonal wind during boreal summer averaged over the equator globally from surface -100-hPa. The correlation pattern replicates the zonal circulations entail Pacific Walker and Atlantic Zonal Circulations. In the same line, the thermocline of equatorial Indian Ocean from surface 300-meter depth is studied. In associating the leading temporal mode, it is found that subsurface produces spatial structures of Indian Ocean mode and Pacific ENSO. Harnessing the deep understanding of subsurface variability will maximize ocean- atmosphere coupling knowledge and long-lead prediction of resources (climate, agriculture, water, economy and the likes). This research will lay the future avenue of ocean-atmosphere coupling understanding.

Keywords: pacificoceanglobalwave, pacificandwalkercirculation, convectionpolaritytnaandtsa

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JMS014 **Oral Presentation** **1172**

A Regulatory Effect of ENSO on the Time-Mean Thermal Stratification of the Equatorial Upper Ocean

Dr. De-Zheng Sun
Earth System Research Laboratory National Oceanic and Atmospheric Administration IAMAS

Tao Zhang

El Nio--Southern Oscillation (ENSO) corresponds to a sloshing of water in the equatorial upper Pacificwater is moved back and forth during an ENSO cycle in both the zonal and meridonal direction. With this observation and in thinking of a laboratory analogue--a container of stratified fluid being repeatedly shaken, one naturally wonder whether ENSO have some significant effects on the time-mean upper ocean thermal stratification of the equatorial Pacific. To investigate the role of ENSO in regulating the time-mean thermal stratification of the equatorial Pacific, perturbation experiments are conducted in pairs with a coupled model. In one experiment, ENSO is turned off while in the other experiment ENSO is kept on. Perturbations are introduced through either enhancing tropical heating or increasing subtropical cooling. In the absence of ENSO, the time-mean difference between the warm-pool SST (Tw) and the characteristic temperature of the equatorial thermocline (Tc) responds sensitively to either enhanced tropical heating or enhanced subtropical cooling. In the presence of ENSO, such a sensitivity to destabilizing forcing disappears. The lack of sensitivity in the response of Tw-Tc is linked to a stronger ENSO in response to the destabilizing forcing. ENSO in the model acts as a basin-scale heat mixer that enables surface heat to be transported to the depths of the equatorial thermocline. The study raises the question whether models with poor simulations of ENSO can give reliable predictions of the response of the time-mean climate to global warming.

Keywords: enso, global warming, ocean stratification

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JMS014 **Oral Presentation** **1173**

In situ observations of diurnal warming in the oceanic skin layer

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University of Miami - RSMAS Remote Sensing Systems

Peter J. Minnett

Observations of diurnal temperature variability in the oceanic skin layer have been primarily available only from satellite SST retrievals themselves. Since most satellite observations revisit the same location only infrequently, determining how the ocean surface diurnal heating responds to variability in forcing (mainly insolation and wind speed) has been primarily addressed through theoretical modeling or extrapolation of results from in situ (buoy) observations measured 0.5 m to 1.5 m below the skin layer. Diurnal heating in the skin layer may be quite different than heating at 0.5 m as this layer responds very rapidly to changes in heat and momentum. The Explorer of the Seas, a cruise ship, makes weekly cruises on two alternating tracks through the Caribbean Sea. Measurements from the Marine Atmospheric Emitted Radiance Interferometer (M-AERI) carried on the Explorer of the Seas provide one of the few skin SST data sets, along with ancillary measurements necessary for diurnal investigations. Initial analyses show that the surface signature of diurnal warming in the skin layer is chiefly controlled by the wind speed. The daily peak in diurnal warming is directly related to the minimum wind speed during the day, causing the time of the peak to shift depending on when the minimum winds occur. Fluctuations in wind speed can result in multiple peaks in diurnal heating during a single afternoon. Wind speed is negatively lag-correlated with diurnal warming while insolation is positively lag-correlated. The maximum lag-correlation of wind speed (insolation) with diurnal warming is at a time lag of 30 (50) minutes. Several models of diurnal variability exist. A comparison of several models with each other reveals considerable differences in estimates of diurnal warming. Further validation of the models using M-AERI observed diurnal warming again reveals considerable differences in estimates of warming related to model forcing parameterizations.

Keywords: diurnal, sst, m aeri

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JMS014 **Oral Presentation** **1174**

Impact of explicit atmosphere-ocean coupling on tropical intraseasonal oscillations

Dr. Wojciech Grabowski
ICCP ICCP IAMAS

Tropical intraseasonal oscillations concern variability of the tropical climate on time scales between several days and a few months and are the strongest mode of atmospheric variability in the tropics. Their best known example is the Madden-Julian Oscillation (MJO), which is a coherent pattern of deep convection, large-scale circulation, and sea-surface temperature that propagates toward the east across the tropical warm pool (eastern Indian and western Pacific Oceans) with a typical speed of 5 m/s. MJO is poorly represented in climate models and it has been suggested that MJO is a coupled atmosphere-ocean phenomenon, where the atmosphere and the ocean work had-in-hand to create the observed variability. This conjecture is supported by simulations using traditional climate models where, typically, enhanced intraseasonal variability is observed when atmospheric model is coupled to the interactive ocean model. This talk will show that this conclusion does not hold when the same problem is investigated in idealized aquaplanet simulations using the super-parameterization coupled to a simple mixed-layer ocean model. In these simulations, the ocean appears to be merely responding to the atmospheric forcing, with, if anything, the negative feedback from the ocean on the atmosphere. An explanation of these conflicting views, involving the positive moisture-convection feedback in the atmosphere and the negative convection-SST feedback in the ocean, will be discussed.

Keywords: convection, mjo, tropics

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Oral Presentation** **1175**

Study of spring predictability barrier problem for El Nino-Southern Oscillation events

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Hui Xu

Most of state-of-the-art climate models have difficulties in prediction of El Nino/Southern Oscillation (ENSO) starting from pre-boreal spring seasons. The causes of this spring predictability barrier (SPB) remain elusive. With a theoretical and then Zebiak-Cane model, we investigate this controversial issue by analyzing the growth behavior of a kind of initial errors given by the approach of conditional nonlinear optimal perturbation (CNOP). It is found that CNOP-type error tends to have a significant season-dependent evolution, and produces most considerable negative effects on the forecast results. Consequently, CNOPs are closely related to spring predictability barrier (SPB). On the other hand, some other kinds of initial errors, whose patterns are different from those of CNOPs, have also been found. Although the magnitudes of such initial errors are the same as those of CNOPs in terms of the chosen norm, they either show less prominent season-dependent evolutions, or have trivial effect on the forecast results, and do not yield SPB for El Nino events. This result indicates that SPB is linked with the spatial patterns of initial errors. To further address the reason of SPB, we use the theoretical ENSO model to illustrate a possible mechanism for SPB, which suggests that SPB for El Nino results from combined effects of three factors: the annual cycle of the mean state, the structure of El Nino, and the pattern of the initial errors. The results help clarifying the role of the initial error pattern in SPB, which may provide a clue for explaining why SPB can be eliminated by improving initial conditions reported by some authors. It suggests that the CNOP-type errors can be considered as one of candidate errors that cause the SPB. If data assimilation or (and) targeting observation approaches possess the function of filtering the CNOP-type or (and) other similar errors, it is hopeful to improve the prediction skill of ENSO.

Keywords: enso, predictability, initial error

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Oral Presentation** **1176**

Investigating Decadal Variability of ENSO Asymmetry by Conditional Nonlinear Optimal perturbation

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Mu Mu

The observed El Nino events are generally stronger than the La Nina events. This property of ENSO is termed as ENSO asymmetry. Evidence is presented to show that this asymmetry has changed since the famous 1976 climate shift. Along the thinking of how the tropical background field modulates ENSO cycle, we explore the effect of the climatological basic-state change on the ENSO asymmetry by applying the approach of conditional nonlinear optimal perturbation (CNOP) in a theoretical coupled model. CNOP is the initial anomaly pattern that evolves into ENSO event most probably. Observation shows that from the pre-shift (1961-1975) to the post-shift (1981-1995) period, significant changes have occurred in climatological background state, i.e., the mean temperature difference between the equatorial eastern and western Pacific basins and between the mixed-layer and subsurface-layer water, which control the ENSO oscillation in the theoretical coupled model. By computing the CNOPs of the climatological basic state corresponding to the 1961-1975 (1981-1995) epoch, we reproduce the observed decadal change of ENSO asymmetry qualitatively. Based on the physics described by the model, the mechanism of ENSO asymmetry change in interdecadal scale is explored in depth. It is shown that the decadal change of ENSO asymmetry is induced by the change of nonlinear temperature advection, which is closely related to the decadal change of the tropical background state. These indicate that the decadal change of ENSO asymmetry results from the collective effect of the changes of the tropical background state and the nonlinearity. These findings in this study also suggest that the nonlinearity can explain not only the asymmetry of interannual ENSO, but also that of interdecadal ENSO, which may present a powerful evidence to the ENSO chaotic theory.

Keywords: enso asymmetry, optimal perturbation, decadal varability

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JMS014 **Oral Presentation** **1177**

Mechanisms of a rapid global climate shift across the late 1960s

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A number of important characteristics of the global atmospheric circulation and climate changed in a near monotonic fashion over the decade, or less, centred on the late 1960s. These changes were largest or commonest in tropical regions, the Southern Hemisphere and the Atlantic sector of the Northern Hemisphere. Some, such as the decrease in rainfall in the African Sahel, are well known. Others appear to be new, but their combined extent is global, and dynamical linkages between them are evident. The list of affected variables includes patterns of SST; tropical rainfall in the African Sahel and Soudan, the Amazon basin and North East Brazil, pressure and SST in the tropical North Atlantic and the West and Central Pacific; various branches of the southern Hadley circulation and the southern subtropical jet stream; the summer North Atlantic Oscillation; south Greenland temperature and the Southern Hemisphere storm track. These changes are often strongest in June-August; changes are also seen in December-February, but are generally smaller. In Greenland, annual mean temperature seems to be affected strongly, reflecting similar changes in SST throughout the year in the higher latitudes of the North Atlantic. Possible causes for these coordinated changes appear to include a likely reduction in the northward oceanic heat flux associated with the North Atlantic thermohaline circulation in the 1950s to 1970s which was nearly in phase with a rapid increase in anthropogenic aerosol emissions during the 1950s and 1960s, particularly over Europe and North America.

Keywords: nineteen sixties, climate, shift

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JMS014 **Oral Presentation** **1178**

Atmospheric circulation influenced by the oceanic subtropical front in the North Pacific

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Although sea surface wind fields over the North Pacific subtropical gyre are generally characterized by anticyclonic circulation with the westerlies to the north and the trade winds to the south, Japanese scientists reported about 40 years ago that a band of cyclonic wind curl may exist in the midst of the subtropical gyre (Yoshida and Kidokoro, 1967), where a sea surface temperature front called the subtropical front exists. The cyclonic wind curl was proposed as a possible mechanism for the formation of the underlying subtropical countercurrent, but it remains puzzling why the cyclonic wind curl occurs there. This study examined the cyclonic wind curl in the subtropical front region by using satellite observations and results from a high-resolution coupled ocean-atmosphere general circulation model. Both observations and model results showed a zonal band of the cyclonic wind curl in 22-27N approximately on the southern flank of the subtropical front. This band of cyclonic wind curls is most pronounced in April and May when the subtropical front maintains sharp sea surface temperature gradients. The cyclonic curl occurs intermittently during spring with a period of several or more days and exhibits eastward propagation, accompanying rain and low sea level pressure anomaly. It was found that a temperature and moisture front forms in the atmospheric boundary layer over the subtropical front. With high temperature and high humidity in the boundary layer, the atmosphere on the southern flank of the front is convectively unstable (equivalent potential temperature decreases upward). An April-May composite analysis reveals that, when the cyclonic curl does not appear, southerly winds are dominant at the sea surface across the front. On the other hand, when the cyclonic curl is present, cold and dry northerly winds blow across the subtropical front. The wind convergence occurs on the southern flank of the subtropical front, causing strong ascending motion up to at least 700hPa as manifested in a local maximum in moisture and cloud water. The upward motion and the latent heating to the atmosphere force a surface cyclonic circulation. The cross-frontal northerly winds are associated with midlatitude anticyclones passing near Japan around 35N. The southward intrusion of the northerly winds triggers convective instability, causing the upward motion and the surface cyclonic circulation on the southern flank of the subtropical front.

Keywords: subtropical front, atmospheric circulation

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JMS014 **Oral Presentation** **1179**

Impact of different Bulk Parameterization schemes of air-sea fluxes on the simulation of Oceanic Heat Content in the Indian Ocean: Comparison with ARGO observations

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Understanding the variability of Oceanic Heat Content (HC) and its anomalies is quite important in the temporal evolution of the coupled ocean-atmosphere system. It is one of the important parameters that lead to cyclogenesis. In the Indian Ocean, especially Bay of Bengal, which is frequently struck by tropical cyclones, HC plays a key role in determining the conditions favorable for such events. Due to lack of in-situ observations over the oceans, estimation of HC (or any other oceanic parameter, say) has been a problem. More recently with the deployment of ARGO floats the observation network in the world oceans have become dense, but still, complete 3-dimesional oceanic fields from these floats are not available on regular basis. Ocean general circulation models (OGCMs) therefore, play a key role in the estimating these fields, however their performance in turn depend upon the atmospheric forcings and the parameterization schemes used in the model. In this particular study we have made use of two different air-sea fluxes bulk parameterization schemes and studied its impact on the simulation of oceanic HC in the Indian Ocean. The simulations have been made using the Modular Ocean Model (MOM-3) forced by scatterometer winds from QuikSCAT for the period 2003-2004. In one experiment (E1) we used the parameterization scheme of Large and Pond (1982) to compute the exchange transfer coefficients of momentum, sensible and latent heat fluxes, while in the other experiment (E2) parameterization scheme of Kara et. al. (2000) was used. HC up to 20 isotherm depth was computed from both the experiments. This was then compared with the climatological HC computed from Levitus temperature profiles. Model was able to reproduce the climatological patterns of HC in both the experiments with E2 simulations closer to climatology. However both the runs showed an underestimation in HC especially in the Arabian Sea. A detailed comparison using collocated (~9500 profiles) ARGO observations for the same period was made. Four regions (Arabian Sea, Bay of Bengal, Somali and Eastern Equatorial IO) in the TIO were selected for comparison. Performance of the two bulk formulations in simulating HC were similar in three regions except for the AS where the Kara et. al. (2000) formulation showed a better performance (8 % improvement over E1). The underestimation in simulated HC was considerably reduced in E2 in the Western IO. The study points out the importance of the careful usage of the air-sea bulk parameterizations in simulating oceanic parameters. A detailed analysis of the statistics and HC variability will be presented in the workshop.

Keywords: argo, indianocean, ogcm

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JMS014 **Oral Presentation** **1180**

The Effect of the Galapagos Islands on the Equatorial Pacific Cold Tongue and El Nino

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A reduced gravity ocean general circulation model of the tropical Pacific Ocean is used to determine potential improvements to the simulated equatorial Pacific cold tongue region due to the Galpagos Islands. Four simulations are performed, with identical climatological forcing. Results are compared between model grids with and without the Galpagos Islands, with coarse and fine resolutions. It is found that a more realistic treatment of the Galpagos Islands results in the obstruction of the Equatorial Undercurrent (EUC), which leads to improvements in the simulated spatial structure of the cold tongue, including a basin-wide warming of up to 2C in the east-central Pacific. The obstruction of the EUC is related to the improvements east of the Galpagos Islands, and for the basin-wide reduction of the tropical cold bias through an equatorial dynamical adjustment. The pattern of SST warming due to the inclusion of the Galpagos Islands is similar to that of the known cold biases in present climate and ocean models, including the Climate Forecast System (CFS) used in the U.S. Such an improvement should also have a considerable impact on the ability of coupled ocean-atmosphere and ocean-ecosystem models to produce realistic clouds, precipitation, biological activity, and carbon cycling in the tropical Pacific Ocean. Finally, the impact of the Galpagos Islands on interannual variability (i.e. ENSO) will be discussed in the context of forced and coupled ocean models.

Keywords: cold tongue, pacific, galapagos

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JMS014 **Oral Presentation** **1181**

A wind-induced thermohaline circulation hysteresis and millennial variability regimes

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The multiple equilibria of the thermohaline circulation (THC, used here in the sense of the meridional overturning circulation) as function of the surface freshwater flux has been studied intensively following Stommel (1961). It is shown here that multi-stability and hysteresis of the THC also exist when the wind stress amplitude is varied as a control parameter. Both the Massachusetts Institute of Technology ocean general circulation model (MITgcm) and a simple three box model are used to study and explain different dynamical regimes of THC and THC variability as a function of the wind stress amplitude. Starting with active winds and a thermally dominant thermohaline circulation state, the wind-stress amplitude is slowly reduced to zero over a time period of ~40,000 years (40 kyr) and then increased again to its initial value over another ~40 kyr. It is found that during the decreasing wind stress phase, the THC remains thermally dominant until very low wind-stress amplitude at which pronounced Dansgaard-Oeschger-like THC relaxation oscillations are initiated. However, while the wind stress amplitude is increased, these relaxation oscillations are present up to significantly larger wind-stress amplitude. Our results thus suggest that under the same wind-stress amplitude, the THC can be either in a stable thermally dominant state or in a pronounced relaxation oscillations state. The simple box model analysis suggests that the observed hysteresis is due to combination of the Stommel (1961) hysteresis and Winton and Sarachik (1993) "deep decoupling' oscillations.

Keywords: thermohaline circulation, relaxation oscillations

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JMS014 **Oral Presentation** **1182**

Interbasin coupling and a birth of the equatorial warm pool

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Atmosphere-ocean coupled processes responsible for generating and maintaining the equatorial warm pool were investigated with a simple theoretical model and an intermmediate coupled model (ICM). The simple system shows that the tropical climate has two equilibria depending upon the ocean basin widths: a single warm pool regime which corresponds to the current climate and a split warm pool regime which accomanies warm pools created in the western basin of each ocean. The latter is not a stable solution hence exhibits a large-amplitude vacillation between ocean basins. A series of the ICM experiments supports the above results and further suggests the atmosphere-ocean-land interaction at work to maintain the observed warm pool.

Keywords: warm, pool

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JMS014 **Oral Presentation** **1183**

Mechanism of biannual cyclicity of ocean and atmosphere processes and phenomenon

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In the report the data of modern geodetic and geophysical observations testifying for the benefit of the author hypothesis (Barkin, 2002) about unity of the mechanism of variations of activity of natural processes of the Earth are discussed. This mechanism is the mechanism of the perturbed relative swing, small turns and mutual deformations of the core and the mantle and other shells of the Earth under the gravitational differential influence on the part of external celestial bodies. Observed displacements of the centre of mass of the Earth (with a wide spectrum of frequencies) on our geodynamic model are caused first of all by identical relative displacements of the centers of mass of the core and the mantle. Thus the superfluous mass of the core by its motion induces the tides, both in the elastic mantle, and in atmosphere and ocean. These tides, naturally, the most direct image influence on the activity practically of all planetary natural processes. Told proves to be true by observed cyclicities and phases of the corresponding atmospheric and oceanic processes. On the basis of GPS data of observations for period 1993 - 2003.8 oscillations of geocenter with the periods characteristic for the phenomenon El Nino, for atmospheric and oceanic processes have been determined (Tatevian et al, 2004; Barkin et al., 2007): 2.1 (3.9 mm); 2.1/2 (1.8 mm); 2.1/3 (1.4 mm); 2.1/4 (3/4 mm). In brackets the estimations of conditional amplitudes are presented in mm. The oscillation with amplitude of 3.9 mm occurs to the basic period of 2.1 approximately in the plane of meridian 90 E and has mainly the polar character. The oscillation of 1.8 mm occurs to the period of 2.1/2 approximately along the Greenwich equatorial axis. The equatorial oscillation with period of 2.1/3 is characterized by amplitude of 1.4 mm. The oscillation (with amplitude of 3.4 mm) occurs to the period of 2.1/4 approximately in the plane of Greenwich meridian. The oscillation of geocenter with period of 8.0 +.-0.4 yr and significant amplitude (11.2 mm) is allocated. At what it, as well as oscillation with period of 2.1 yr, occurs approximately in the plane of meridian 90 E. And also has mainly polar character. The oscillation with period 3.24 +.-0.5 years (and amplitude of 4.5 mm) occurs along the equatorial axis of the zero meridian. The oscillation with period of 3.6 +.-0.1 yr and amplitude of 7.0 mm has a polar character. On our geodynamic model the similar cyclicities characterize relative displacements of the Earth shells and, hence, they should be shown in all natural processes, including El Nino. Really, the spectral analysis of long temporal series of indexes SOI since 1866 yr till 1996 yr and index DT since 1851 yr till 1996 yr has allowed to reveal oscillations with periods 6 yr, 3.6 yr, 2.8 yr, 2.4 yr. A feature of the revealed periods is noticed - all of them are to some extent multiple to the period of precession of lunar orbit in 18.6 years and to the Chandler period of the pole motion of 1.2 years (Sidorenkov, 2002). The atmospheric and oceanic tides with mentioned (and others) cyclicities caused by the gravitational attraction of displaced superfluous mass of the core (relatively to elastic mantle) are studied. The properties of their space and temporal display on the Earth are investigated. The obtained results confidently prove to be true the data of studies of spectrums of variations of gravity and variations of heights on gravimetry stations: Moscow, Ђestakhavi, Hannover etc. (measurements on absolute gravimeters in 1996-2000; Kaftan et al., 2004). In more wide sense discussed here mechanism of the mutual interaction and oscillations of the Earth shells directs, dictates and controls all known phenomena: ENSO, NAO, Northern and Southern Annular Modes, Pacific Decadal Oscillation and others dominant modes of variability. References Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian. Sidorenkov N.S. (2002) Physics of no stabilities of rotation of the Earth. M.: "Nauka" Fizmatlit, 384 p.

Tatevian, S.K., Kuzin, S.P., Kaftan, V.I. (2004) Comparison of geocenter variations derived from GPS and DORIS data. Report of EGU (25-30 April 2004, Nice, France).Kaftan V.I., Gusev N.A. (2004) Temporal changes of a gravity at Moscow station FAGS. The scientific and technical collection on a geodesy, aerospace photo cartography ("Physical geodesy"). M., ZNIIGAIK, v. 5, pp. 136-146. Barkin Yu.V., Lyubushin A.A., Zotov L.V. (2007) The geocenter motion and its geodynamical contents. Materials of Sagitov Conference (5-6 February 2007, Moscow). Sternberg Astronomical Institute, MSU: www.sai.msu.ru.

Keywords: biannual oscillation, elnino, core mantledynamics

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JMS014 **Oral Presentation** **1184**

Responses of extratropical cyclone activity to the Gulf Stream SST gradient

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Responses of the atmosphere to the Gulf Stream SST gradient are investigated using an atmospheric general circulation model with T239 (about 50 km) horizontal resolution. An experiment using observed daily SST data on a 0.5 degree grid for 5 years shows precipitation concentrated along the Gulf Stream, consistent with satellite observations. However, the other experiment using horizontally smoothed SST data over the Gulf Stream front does not produce such concentrated precipitations. The frequency of extratropical cyclones occurrences over the SST gradient also decreases in the smoothed SST experiment. Especially, the frequency of weak cyclones in formation stage decreases. Composite analysis of precipitation shows that precipitation seems to precede cyclone formation. These results suggest that the SST gradient affects precipitation pattern and extratropical cyclone activity.

Keywords: extratropical cyclone, sst gradient, gulf stream

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JMS014 **Oral Presentation** **1185**

The importance of the wind stress and wind stress curl for the upwelling along the California Coast in June 1999

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The US northwest Pacific coast is embedded within the California Current System, a classical eastern boundary current and a well-known upwelling area. Recent in situ and satellite data analysis as well as modelling studies reveal complex spatial and temporal variability of the whole system, in which the wind stress is an important driving mechanism. The circulation along the California Coast in June 1999 was influenced by strong upwelling-favourable winds. Wind field was simulated with Mesoscale Model 5 (MM5), whose results were highly correlated with satellite and in situ wind measurements. Detailed analysis of the wind stress and wind stress curl reveal a pattern with positive wind stress curl ina narrow band along the coast and a wide area with negative wind stress curl further offshore, which resulted from spatial distribution of the wind velocity maxima and the changes in the orientation of the coastline. To study the wind-induced circulation and the importance of the wind stress curl, Princeton Ocean Model (POM) was setup for the California and Baja California coasts. MM5 outputs were used for forcing POM with interactively calculated wind stress and heat fluxes. In the basic experiment initial conditions for thetemperature field were determined from the sea surface temperature (SST) used in the MM5 simulation with a climatological vertical profile. The initial salinity field was homogeneous and the velocity field was initialised witha state of rest. Modelled surface currents indicate off-shore flow in the deep areas and dominant poleward current in the near-shore area. At the beginning of the month offshore currents are present in the whole domain but the strength of the poleward near-shore current is increasing with time. Besides the basic experiment, several sensitivity studies were performed to study the influence of the wind stress curl, initial density gradients, bottom topography, interaction with deeper ocean and horizontal resolution of the models. The alongshore poleward current obtained in the basic experiment and supported by direct measurements is replaced with equatorward currentin the curl-free experiment. Furthermore, a significant temperature dropoccurs along theentire coast in the curl-free experiment, whereasthe areas of maximum upwelling are limited to the regions with wind maximumin the basic experiment. Modelling results were compared with SST satellite estimates and in situ measurements of temperatures and currents. Hourly SST measured at thirteen NCDC buoys were used to evaluate sensitivity studies by RMS errors of the corresponding model results.

Keywords: numerical modelling, wind stress curl, upwelling

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JMS014 **Oral Presentation** **1186**

Large scale interaction of ocean-atmospheric coupling during contrasting Indian summer monsoons

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Babu Ca

Indian and western Pacific Sea Surface Temperature (SST) interactions with convection and the atmospheric circulation pattern associated with a coupled ocean-atmospheric system is the most important component of the Asian summer monsoon variability. In this study various diagnosis have been applied to provide a comprehensive description of the Indian monsoon rainfall features on the monthly, seasonal and intra seasonal time scale. Large significant positive correlation with a band of warmer/colder SST anomaly axis that extends from Indian Ocean to the west Pacific (WP) explores its relation with convection. The empirical orthogonal function analysis proves the monthly evolution of the basic state SST field and associated convection band, closely resembles in a systematic pattern which could be explained using SST gradient (north-south) mechanism as in the equatorial Pacific (east-west). The analysis using NOAA OptimumInterpolation SST for 1982 to 2005 and GPCP pentad rainfall data for the same period were used for the present study. For good implication of the results TMI SST (25 km) and GPI- 1DD rainfall data (1) for a period 1998 to 2005 are also used. Our results support the theories of moisture feed back through the Low Level Jet stream (LLJ) at 850 hPa (NCEP/NCAR) which positively feeds the convection with maximum correlation in a lag of 3 to 4 day, convection leading. An anomalous north-south SST gradient shifts the meridional location of maximum convection to 10N latitude and leads deep convective activity over the Bay of Bengal (BOB). We examined the processes underlying the anomalous 850 hPa circulation and found a consistency in the suppression of convection over the BOB through the decaying of SST gradient. Consecutive warming of the northwestern Pacific brought a band of convection towards the warm anomaly region. For the SST gradient mechanism our results confirm previous studies that link convection and cross-equatorial winds forced by SST gradients. We find that positive surface flux feedback brought about the cross-equatorial winds still stronger over the BOB and extend towards the WP convection zone confirming the deep convective activity. Linear correlation coefficient between convection in an extended area between 80E and 150E and the LLJ is 0.56 but the correlation between convection in WP and the LLJ is much higher (nearly 0.67) is strengthening this explanation. This leads that the LLJ that is still stronger is responsible to channelise all moisture towards the convection zone of WP. This is strongly associated with the long breaks of Indian summer monsoon especially in July 2002, which was an extreme long break and leads to a deficient Indian monsoon during 2002. In the intra seasonal time scale this study leads to a key role to explain the long breaks in the Indian summer monsoon. On the basis of the results, we propose an expanded physical explanation for features of monsoon variability, including its seasonal, intra seasonal and monthly cycles and its sensitivity to small anomalous SST gradients and its role in the context of Indian and western Pacific SST variability.

Keywords: sstgradient, llj, longbreaks

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JMS014 **Oral Presentation** **1187**

Atmosphere-sea interaction and pronounced diurnal variability in the Adriatic shelf-break area

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The presentation is based on a project, called ITHACA, whose field phase was carried out between February and September 2006 in the Adriatic shelf-break area. During the experiment (1) meteorological conditions were documented by permanent stations in the area (Split-Marjan, Dubrovnik, Komiza, Hvar and Palagruza), (2) optical surveys were performed on two occasions at three stations, (3) shipboard CTD surveys were carried out on four occasions at an along-basin transect comprising thirteen closely spaced stations, (4) thermistor time series were collected on the islands of Lastovo, Susac and Bisevo utilizing 3 x 10 sensors deployed on steep cliffs opened to the southeast, (5) ADCP measurements were continuously performed at three stations using trawl-resistant bottom mounts (called barnys), and (6) surface tides were monitored at the permanent Split and Dubrovnik stations and at one of the ADCP stations. The project was successful, as all the instruments were recovered except one of the thermistors. Preliminary analysis of the data collected has shown that the east-coast inflow to the Adriatic underwent a summertime change recorded in July 2006 at two of the ADCP stations, between May and July 2006 at one station. Inertial oscillations were well visible in both the temperature and ADCP time series. Subsurface temperature oscillations, characterized by the 24, 12 and 8 h periods, were pronounced at one of the islands (Lastovo). The corresponding baroclinic current variability was largest at a nearby ADCP station and was bottom-intensified. Apparently, the signal was partly related to internal tides and partly to periodic upwelling events that were driven by varying winds especially strongly in July 2006. A possible feedback of the sea on the atmosphere at the daily time scale is briefly discussed.

Keywords: wind, periodic upwelling, diurnal cycle

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Oral Presentation** **1188**

Different types of oscillations in and above the surface layer over East Equatorial Indian Ocean during monsoon season

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Indian summer monsoon is characterized by different types of oscillations starting from high to low frequency oscillations. These oscillations/waves are important to understand the physics and dynamics of monsoon structure. Different types of oscillations in atmospheric boundary layer and above are investigated over Equatorial Indian Ocean. The data used for the study is TMI sea surface temperature (TMISST), QuikSCAT surface wind, NCEP/NCAR reanalysis wind at 925 hPa, 850 hPa levels and NOAAOLR for the indication of organised convection. The TMISST and QuikSCAT wind having a spatial resolution of 0.25 X 0.25 latitude longitude grid and NOAAOLR and NCEP/NCAR wind having a spatial resolution of 2.5 X 2.5 latitude longitude grid. All these data sets have proved its quality in scientific research. East equatorial Indian Ocean is a region, in which the SST shows variability and this variability/horizontal SST shear may act as trigger for the formation of organised convective clouds in the monsoon domain. The different kinds of variabilities embedded in the monsoon system is identified using wavelet technique. In this presentation, we made an attempt to explore the different types of oscillations in the surface, atmospheric boundary layer and free atmosphere during the southwest monsoon period. Surface boundary layer characteristics over the monsoon region are closely linked to the upper air monsoon features. So, the study of the various oscillations in the surface layer and above is important. From the analysis, we observed that, prominent oscillation in the SST is Intra seasonal oscillation (ISO). In addition to this, high frequency variabilities are also there, but their relative influence in the formation and maintenance of monsoon is less. We also unraveled the variabilities in the wind at surface, 925 hPa and 850 hPa levels. The dominant variability found in the surface layer is 10-20 day mode also called Quasi Biweekly Mode (QBM) but in the layer above the surface layer (925 hPa and 850 hPa) the main oscillation is ISO mode. The reason for the QBM in the surface layer may be due to the frictional and other drag effects in the atmospheric boundary layer and the ISO mode above the surface layer is due to the influence of the large sale circulation as part of the monsoon surge. It is also noticed that the SST and wind above the surface layer show the dominant mode as the ISO band but QBM is dominated in between the oceanic surface and the layer above the boundary layer surface.

Keywords: atmospheric surface layer, quasi biweekly mode, inraseasonal oscillation

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JMS014 **Oral Presentation** **1189**

The tropical atlantic variability in an intermediate coupled model: the 1996 equatorial warm event

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We investigate the inter-annual warm event that occurred in the Equatorial Atlantic in boreal spring-summer 1996. The role of local coupled air-sea interactions versus Tropical Pacific remote forcing is analyzed using observations and ensemble experiments of an Intermediate Coupled Model (ICM) of the Tropical Atlantic. The oceanic component of ICM consists in a linear 6-baroclinic-mode ocean model, in which a mixed layer model is embedded. The atmospheric component is the global general circulation atmospheric model developed at UCLA. Results show that the persistent anomalous cold conditions in the Tropical Pacific over 199596 were favorable to the growth of the local air-sea interactions that led to the 1996 warming in the equatorial Atlantic. Based on the estimation of the changes in the Walker circulation over the Pacific and Atlantic for the meteorological reanalyses and the coupled model, a mechanism of Pacific-Atlantic equatorial connection is proposed to explain this particular warm episode.

Keywords: equatorial atlantic, air sea interactions, enso remote forcing

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JMS014 **Oral Presentation** **1190**

Heat Transport and Clinate Variability in the Coupled Ocean-Atmosphere System

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We will discuss the heat transport and the climate variability in the coupled ocean-atmosphere system. Theoretical arguments suggest that at low latitudes the heat transport in the ocean will robustly dominate that of the atmosphere, and this is consistent with observations. On the other hand, in mid- and high-latitudes the heat transport in the atmosphere is observed to dominate. Theoretical arguments suggest that this dominance is parameter dependent, and will depend on such things as the diapycnal diffusivity in the ocean, the width of the ocean basin, the rotation rate of the earth, the presence or otherwise of a zonally periodic ocean channel in the Southern Hemisphere (or elsewhere), and the atmospheric deformation radius, which in turn is a function of the flow regime. We present various scalings for heat transports in different latitudes and in different regimes to elucidate these dependencies. Using various configurations of an idealized, coupled, primitive equation model, we test some of these predictions, including the ability of the atmosphere to compensate for changes in the oceanic and atmospheric configuration and so keep the total meridional heat transport in the coupled system roughly constant. Using both a mixed-layer ocean model, and a fully dynamical ocean model, we also explore the variability in the atmosphere-ocean system on timescales of decades to centuries. Specifically, we investigate the timescales on which can the system be considered as truly coupled; what, if any, the role of ocean dynamics are on redenning the atmospheric response; and whether 'weather' variability in the atmosphere plays an essential role in longer term variability.

Keywords: coupled, ocean atmosphere, climate

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Oral Presentation** **1191**

Upper ocean warming and tropical cyclones

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Kerry Emanuel

Vertical mixing in the ocean upper layer is strongly affected by intense winds. In turns, upper ocean heat content affects the evolution of tropical cyclones. We present results from a modeling study of the possible feedback between upper ocean heat content and hurricanes. The model indicates that for given atmospheric thermodynamical conditions, regimes characterized by intense (with deep mixing and large upper ocean heat content) and by weak (with shallow mixing and small heat content) tropical cyclone activity can be sustained. The feedback also amplifies the sensitivity of modeled cyclone power dissipation to atmospheric thermodynamic conditions. Observational data are discussed in light of the described interaction.

Keywords: air sea interactions, tropical cyclones, mixed layer

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JMS014 **Oral Presentation** **1192**

The influence of ocean dynamics and orography on northern hemisphere storm tracks

Dr. Chris Wilson

Dr Bablu Sinha, Prof Ric Williams

A coupled climate model (FORTE) is used to determine the separate influences of ocean dynamics, orography and their nonlinear interaction on the northern hemisphere winter mean storm tracks. From a 'ground state' having flat continents and a static, mixed layer ocean, the structure of the storm track is examined. By adding forcing to this ground state through combination of orography and ocean dynamics within four model runs, the individual processes controlling the storm track are identified and the relative influence of the forcing is determined.Ocean dynamics shift the storm track poleward and induces northeastward tilt over the Atlantic. Orographic forcing causes along-track variability in the storm track and northeastward tilt over the western Pacific. The nonlinear interaction between orographic and ocean dynamical forcing modifies generation and maintenance of the storm track, rather than the storm track variance itself.To model the quasi-steady state of the storm tracks, a coupled climate model must be used, which has an ocean that interactively supplies heat to the storm track latitudes.

Keywords: storm, track, ocean

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JMS014 **Oral Presentation** **1193**

Air-sea interaction monitoring by remote and contact measurements: the results of the CAPMOS'05 experiment on an oceanographic platform in the Black Sea

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Goryachkin Yury N., Komarova Natalia Y., Kuzmin Alexey V., Pampaloni Paolo, Repina Irina A., Zecchetto Stefano

It hardly needs saying that the modern oceanography cannot be conceived without satellite data. Remote sensing satellites provide means for global operational monitoring of ocean and atmosphere parameters. At the same time, the accuracy and validity of remote sensing data depend on the quality of the models related particular geophysical parameters to the parameters of electromagnetic waves emitted/scattered by natural media. To develop and test these models, accurate in situ measurements are necessary. Among other means of in situ measurements like research vessels or buoys, the oceanographic platforms are of particular importance because they provide a unique opportunity of long-term measurements of sea and atmosphere parameters in a fixed point using various kinds of sensors, both remote and contact. A number of resembling platforms in the Mediterranean region is very limited, and each of them provides very important experimental data for global/regional models tests, satellite sensors calibration/validation, novel remote sensing algorithms development, etc. The paper presents the results of the experiment CAPMOS05 performed on an offshore oceanographic platform in the Black Sea in June 2005. The experiment aimed at investigations of air-sea coupling by means of direct and remote measurements was carried out in frames of the INTAS project "Combined Active / Passive Microwave Measurements of Wind Waves for Global Ocean Salinity Monitoring (CAPMOS)". The project joined several research teams from Russia, Ukraine and Italy experienced in experimental study of ocean and atmosphere. A specialized research platform managed by the Marine Hydrophysical Institute is located on the shelf slope approximately 600 m to the south of Crimea coast, Ukraine. The sea depth at the site is 30 m, so the deep water and long fetch conditions were ensured for prevailing winds from the south, south-east and south-west. List of research instruments and equipment used in the experiment included: below the surface: five current meters at a depth of 3, 5, 10, 15 and 20 meters; bottom to top CTD sections every 3 hours; water temperature sensor at 1 m; water turbulence sensor at 1 m; CTD floating at a depth of 0.3 meters; 6-strings wave gauge; above the surface: 3-component sonic anemometer and air temperature sensor - at 1.5 m; radio-interferometer for precise measurements of water surface, a set of microwave and IR radiometers mounted on an automatic rotator, 3-component sonic anemometer and air temperature sensor, water vapor and carbon dioxide sensor - at 4 m; Ku-band scatterometer (polarizations VV, HH or cross), air pressure sensor - at 14.5 m; 3-component sonic anemometer, air temperature and humidity sensor - at 21 m. The measurements on a platform were carried during June 1-20 round a clock. The weather conditions during the experiment were favorable for the measurements. The mean wind speed ranged from 0 to 13 m/s; two episodes of high wind speeds were observed, with gusts well above 20 m/s. The boundary layer conditions were mostly stable (60%) or neutral (30%); several episodes of the air-sea coupling drastic change caused by upwelling or the Azov waters intrusion were observed. Combined analysis of remote sensing and contact measurements provided an evidence of these events. Spatial structure and temporal evolution of these phenomena was also traced by the NOAA satellite. The study was supported by INTAS Grant 03-51-4789 and RFBR Grant 05-05-64451.

Keywords: air sea interaction, platform

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JMS014 **Oral Presentation** **1194**

Dynamics of short waves spectrum measured by remote and contact sensors from an oceanographic platform

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Short gravity and gravity-capillary waves play very important role in ocean-atmosphere interaction affecting momentum exchange through wind waves generation and dissipation. At the same time, short waves affect the electromagnetic waves emission and scattering from a sea surface, and this effect is used in satellite radiometers and scatterometers for remote measurements of winds over ocean. The relations between wind, waves and emitted/scattered signal are extremely complicated and can hardly be described unambiguously by any theoretical model. Therefore experimental measurements of the ocean-atmosphere interaction parameters under various meteorological conditions are of high importance. The paper presents the results of the experiment CAPMOS'05 performed on an offshore oceanographic platform in the Black Sea in June 2005. The experiment aimed on investigations of air-sea interaction by means of direct and remote measurements was carried out in framework of the INTAS project "Combined Active / Passive Microwave Measurements of Wind Waves for Global Ocean Salinity Monitoring (CAPMOS)". The project united experienced research teams from Russia, Ukraine and Italy. A specialized research platform managed by the Marine Hydrophysical Institute provided a unique opportunity of long-term measurements of sea and atmosphere parameters using remote and contact sensors. The following remote sensors were used: radio-interferometer for precise measurements of water surface; Ku-band scatterometer (polarizations VV, HH or cross); L-band radiometer; S-band radiometer (V-pol.); K-band radiometer (3 Stokes parameters); Ka-band radiometer (3 Stokes parameters); W-band radiometer (V- and H-pol.); IR-radiometer (8-12 mkm); optical digital camera. List of contact sensors for atmosphere and sea parameters measurements included: three 3-component sonic anemometers at 1.5, 4 and 21 meters above the surface; air pressure and humidity sensors; three air temperature sensors; water vapor and carbon dioxide sensor; 6-strings wave gauge; two CTDs; five current meters at a depth of 3, 5, 10,15 and 10 meters; water turbulence sensor. The measurements on a platform were carried during June 1-20 round a clock. The weather conditions during the experiment were favorable for the measurements. The mean wind speed ranged from 0 to 13 m/s; two episodes of high wind speeds were observed, with gusts well above 20 m/s. The boundary layer conditions were mostly stable (60%) or neutral (30%); several episodes of the air-sea coupling drastic change caused by upwelling or the Azov waters intrusion were observed. The parameters of gravity wave spectrum were measured by a wave gauge. The curvature spectrum of gravity-capillary waves and gravity waves slope variance were retrieved from remote radiometric measurements using an original algorithm. The dynamics of waves at different bands of spectrum under the conditions of variable wind was investigated. The study was supported by INTAS Grant 03-51-4789 and RFBR Grant 05-05-64451.

Keywords: microwave radiometry, gravity capillary waves

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JMS014 **Oral Presentation** **1195**

Ocean-atmosphere coupling in a high resolution climate model

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James Harle, Adrian New, Warwick Norton, Len Shaffrey, Julia Slingo, Ian Stevens

The UK-HiGEM consortium has developed a new coupled ocean-atmosphere climate model of unprecedented resolution. The model is based on the UK Met Office HadGEM1 climate model but with increased resolution in the atmosphere and ocean and improvements to some parameterisations. The ocean has a horizontal resolution of 1/3 degree longitude by 1/3 degree latitude (approximately 35 km) and 40 vertical levels. The atmosphere has a horizontal resolution of 5/4 degree longitude by 5/6 degree latitude (approximately 90 km) with 38 vertical levels. Large-scale measures of the model performance are generally in good agreement with observations and other models. The model integrations have yielded some important results concerning the interaction between fine scale atmospheric and oceanic structures. In particular, the model is of sufficient resolution to realistically simulate tropical instability waves in the eastern tropical Pacific. Strong sea surface temperature gradients drive perturbations in the overlying wind field and the whole system propagates westwards along the equator. The mechanisms involved in such ocean-atmosphere coupling and their implications are examined.

Keywords: high resolution, coupled modelling

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JMS014 **Oral Presentation** **1196**

Variability of temperature and currents during an upwelling event off the Western Iberian Coast

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A numerical ocean model (ROMS) was applied to a region close to the western Iberian coast in order to study changes in the currents and sea surface temperature fields, observed during an upwelling event. The model was forced with surface meteorological data from ECMWF reanalysis. The meridional and zonal components of the currents and the sea surface temperature time series are analyzed at three distinct locations along the western Iberian coast, during a period of 62 consecutive days, when two upwelling events were observed. In addiction, the trajectories followed by Lagrangean floats released at several locations at different times are described. Using the vertical and horizontal currents obtained with the numerical model anexplanation of the 3D ocean circulation is made, associated with upwelling.The structure of the meridional northward counter-current, in a narrow region close to the western Iberian coast, due to a sea surface height anomaly observed in this region, is discussed.

Keywords: upwelling, temperature

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Oral Presentation** **1197**

Evolution and structures of tropical instability waves in the Pacific Ocean

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George N. Kiladis, Paul E. Roundy

Sea surface height (SSH), sea surface temperature (SST), winds and surface currents derived from satellite observations are analyzed to investigate intraseasonal variability of upper ocean and atmospheere in the eastern tropical Pacific. Wavenumber-frequency spectral analyses of SSH and SST anomalies were performed in order to examine space and time variations of these variables. Significant spectral peaks along the dispersion curve of first baroclinic mode Rossby and Kelvin waves are found in the SSH spectrum, indicating that the analysis can effectively identify the signals of equatorial waves in the upper ocean. A prominent peak in SSH fields at around 33 days and 1500 km wavelength along the Rossby wave dispersion curve is evident, and a similar peak is also found in SST fields. This upper ocean variability on these space and time scales is shown to be associated with tropical instability waves (TIWs). The spatial and temporal structures of 33-day TIWs are further examined based on an analysis of time series filtered in the frequency-wavenumber domain. The maximum variability of SSH associated with TIW is located around 5N, 130W, while that of SST is found around 2N, 100W. The evolution of SSH, SST, surface velocity, winds and cloudiness associated with TIWs and their phase relationships are described based on the cross-correlation analysis. The results show that these statistical analyses are able to isolate salient features of TIWs and their associated air-sea interaction signals.

Keywords: air sea, interaction

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JMS014 **Oral Presentation** **1198**

More high latitude rains, more North Atlantic overturning?

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It is commonly thought that global warming will strengthen the hydrological cycle, leading to enhanced freshwater input to the North Atlantic and ultimately a reduced meridional overturning circulation. We propose instead that, at least over multi-centennial timescales, a stronger hydrological cycle will in fact increase the Atlantic meridional overturning circulation. Here, we present results from an ocean general circulation model (MOM4) coupled to an ice model and an energy-moisture balance model for the atmosphere. The hydrological cycle is artificially enhanced (or reduced) by increasing (decreasing) the models atmospheric temperature in the calculation of the saturation mixing ratio. We find that a stronger hydrological cycle reduces convection in the Southern Ocean and North Pacific but increasesconvection in the North Atlantic. The results can be understood if we combine the following two arguments. 1) If the interaction between the hydrological cycle and the continental orography is causing the Atlantic to be the preferred basin for deep convection, then it stands to reason that a stronger hydrological cycle will amplify this preference. 2) Recent arguments for an energy constrained large scale circulation suggest that it is unlikely that the overturning will be significantly reduced everywhere under a steady mechanical energy supply. Thus, we argue that increased high latitude freshwater input will reduce the deep convection preferentially in the Southern Ocean and North Pacific due to (1), and over long timescales an increase in deep convection in the North Atlantic will compensate for the reduction in the other basins due to (2).

Keywords: north atlantic, hydrological cycle, meridional overturning

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JMS014 **Oral Presentation** **1199**

A Regional Atlantic Ocean-Atmosphere Coupled Climate Model

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Ping Chang, R. Saravanan

We have developed a Coupled Regional Climate Model (CRCM) of the tropical Atlantic region. The ocean component is based on the Regional Ocean Model System (ROMS) and has a horizontal resolution of 1/4 degree in longitude and latitude with 30 vertical layers. The model domain extends from 35S to 50N and from 80W to 20E and incorporates open boundary conditions at the northern and southern boundaries. This regional ocean model is coupled to a version of the fifth generation NCAR/Penn State Mesoscale Atmosphere model (MM5) which covers the same horizontal domain with a horizontal resolution of 90 KM and 23 vertical layers. By using a regional ocean model, we simulate ocean circulation at finer spatial resolutions to better resolve ocean currents and eddies. By coupling this model to a regional atmospheric model, we resolve ocean-atmosphere interactions in the mesoscale regime, in addition to being able to better resolve atmospheric processes. We show that the CRCM realistically simulates coupled ocean-atmosphere variability at a wide range of time and spatial scales, including tropical instability waves at subseasonal time scales and the Atlantic meridional and zonal modes at interannual to decadal time scales.

Keywords: coupled models, ocean circulation, climate models

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS014 **Poster presentation** **1200**

Mechanistic studies of the role of Wind-Evaporation-SST feedback in ocean-atmosphere interaction

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The Wind-Evaporation-SST (WES) feedback is believed to play an important role in thermodynamic ocean-atmosphere interaction. In the tropical Atlantic, the positive feedback associated with the WES feedback can lead to amplification of the interhemispheric gradient mode variability. It has also been argued that this feedback can communicate high-latitude Atlantic cooling to the tropical Atlantic. In the tropical Pacific, the WES feedback can help explain the propagation of westward propagation of SST anomalies purely through thermodynamic air-sea interaction. However, it is often difficult to conclusively identify the role of the WES feedback using observational analysis, or even by analyzing comprehensive coupled ocean-atmosphere general circulation models (GCMs), because the WES feedback may be masked by other processes. In this study, we report on studies using a modified version of an atmospheric GCM (AGCM), where the WES feedback is deliberately suppressed in the bulk aerodynamic formulation for surface fluxes. By comparing coupled integrations using the modified AGCM to those carried out using the control AGCM, we can focus on the role of the WES feedback. Preliminary results for tropical Atlantic region show that the WES feedback does lead to increased variability, and also helps explain why the ITCZ tends to stay north of the equator.

Keywords: wind evaporation sst, tropical atlantic

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JMS014 **Poster presentation** **1201**

Tropical SST role on the anomalous 2002 SH polar vortex

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Gianluca Redaelli, Guido Visconti

The stratospheric winter of 2002 in the Southern Hemisphere (SH) was particularly unusual. Characterized by a weaker than normal vortex during all the season, it registered, during the end of September, the first Stratospheric Sudden Warming yet observed in the SH. This type of event is unexpected because the forcing of upward propagating tropospheric waves is usually weak in the SH. The preconditioning of the polar vortex, starting at the beginning of the winter, has been supposed to be crucial. Recent model studies have suggested that the winter polar vortex may be sensitive to the tropical oceanic conditions. In this paper, the response of the polar SH to the 2002 tropical Sea Surface Temperature (SST) is simulated. Model results show a primary role played by tropical SST on the development of the peculiar 2002 Antarctic polar atmospheric dynamics.

Keywords: atmosphere dynamics, climate models, teleconnection

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **1202 - 1230**

Symposium
Mid-latitude Droughts in a Changing Climate

Convener : Prof. Christoph Schär
Co-Convener : Dr. Sonia Seneviratne, Prof. Stefan Brönnimann

The aim of this session is to bring together scientists that investigate mid-latitude droughts from various perspectives using observational, diagnostic or modeling approaches. The symposium invites papers from a wide range of themes: case studies of recent droughts (e.g. the European heat wave of 2003, the Iberian drought of 2005), mechanisms and dynamics of droughts (including the role of oceanic and atmospheric drivers and land-surface processes), variability and trends of droughts (using observations and/or proxy data), and modeling studies addressing the role of climate change and climate variability for the occurrence of droughts.

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JMS015 **Oral Presentation** **1202**

Developing and evaluating drought characteristics using Markov chain

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Drought is common yet not commonly understood. This paper provides an approach for expressing drought characteristics within a probabilistic framework. Markov chain model has been used extensively to evaluate the probabilities of the occurrences of sequences of wet and dry periods. These sequences of wet and dry spells help in understanding the drought- proneness by means of a simple index. Weekly precipitation data from several climatological stations for the period 1961-2003 are used to determine the drought-proneness, based on the parameters of the Markov chain model. Markov chain model were used to compute 1) absolute probabilities; 2) probabilities of dry sequences longer than 12 weeks and 3) expected value of the length of drought period. The standardized precipitation index (SPI) based on 53 years '1951-2003' of monthly precipitation data is computed and drought proneness is estimated for several climatological stations in Iran. Drought classes, derived from SPI, were used as input to the Markov chain model. Markov chain model was used in order to estimate: 1) the probability of different drought severity classes; 2) the expected time in each class of severity; 3) the recurrence time for a particular class; 4) the expected time for the SPI to change from a particular class to another, and 5) the short term conditional probabilities of drought classes. The persistence of recent climate condition tends to dominate, hence limiting the prediction capability of Markov chain model. If the present drought class is moderate or severe, the probability of being one month from now in the same drought class is higher than the probability of changing to another class. Results show that the Markov chain model is an appropriate tool for estimating drought-pronencess.

Keywords: drought, markov chain model

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JMS015 **Oral Presentation** **1203**

Long-term drought variability for the Mississippi basin from a novel application of the water budget equation

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Jin-Ho Yoon, Annarita Mariotti, Sean Swenson

In an approach termed the P-E-R (or simply PER) method, we apply the basin water budget equation to diagnose the long-termvariability of the total terrestrial water storage (TWS). The key input variables are observed precipitation (P) and runoff (R), and estimated evaporation (E). Unlike typical offline land-surface model estimate where only atmospheric variables are used as input, the direct use of observed runoff in the PER method imposes an important constraint on the diagnosed TWS. We apply this P-E-R method to the midlatitude Mississippi basin and discuss the impact of major 20th century droughts such as the Dust Bowl period on the long-term water variability. The multidecadal TWS variability for both basins has an amplitude up to 600 mm, much larger than model simulated soil moisture changes. While we currently lack independent means to verifythese long-term changes, such large variability implies the remarkable capacity of land-surface in storing and taking up water. The results also suggest the existence of water storage memories on decadal time scales, significantly longer than typically assumed seasonal timescales associated with surface soil moisture. We also compare the results to the Amazon and showthe linkage of this method to satellite gravity estimates from NASA's GRACE mission.

Keywords: drought, soilmoisture, variability

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1204**

The Summer North Atlantic Oscillation (SNAO) since the eighteenth century

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Dr David Fereday, Dr Hans Linderholm, Dr Jim Hurrell, Miss Sarah Ineson, Dr Jeff Knight, Dr Adam Scaife

Eigenvector analysis of mean sea level pressure data gives an NAO- like pattern in summer but whose scale is smaller than in winter. Its southern node stretches from near UK to Scandinavia. Here we concentrate on July and August or high summer. When the southern node of the SNAO has higher pressure (positive SNAO), warmth and dryness is seen. The SNAO varies strongly interannually in high summer, but also interdecadally. Regression analysis of the SNAO with sea surface temperature (SST) suggests that its interdecadal variations can be related to the Atlantic multidecadal oscillation. Because the SNAO strongly affects temperature and rainfall in Scotland and Scandinavia, paleoclimate data based on tree rings has been used to reconstruct an index of the SNAO back to the eighteenth century. Finally, simulations with a version of the Hadley Centre coupled model forced by enhanced concentrations of atmospheric carbon dioxide show a tendency for more positive values of the SNAO, amplifying the future effects of global warming in summer in North-West Europe.

Keywords: summer, drought, paleoclimate

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1205**

Changes in australian droughts using a simple water-balance model

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The extreme severity of recent droughts in parts of eastern Australia has lead to questions about changes in drought behaviour. The acute physical impacts felt within a number of sectors, especially water resources and agriculture, have lead this study to determine past and potential future changes to drought frequency, length and severity for the Australian region. Drought has often been analysed using a meteorological drought definition that assesses changes in rainfall alone. This concept of drought neglects potentially important changes in evaporation, which can also influence soil, river and lake hydrology. To incorporate the effects of evaporation, this study uses a simple water-balance model to estimate changes in extreme soil moisture deficiency, which is considered a better drought index than extreme rainfall deficiency. The water-balance model is based on a simple bucket scheme that measures the effects of rainfall and evaporation on the available water capacity (AWC) of the soil. Infiltration into the ground is ignored and all excess water is treated as run-off. Evaporation is determined using Mortons Complementary Relationship for Areal Evaporation which determines areal and potential evaporation from temperature, precipitation, vapour pressure and radiation. The AWC of the soil is determined by combining the AWC from the topsoil and the subsoil from a high-resolution soil data set. Drought is defined as an abnormal deficiency in soil-moisture, i.e. when the soil-moisture is below the long-term 10th percentile. Monthly drought intensity, frequency and length are calculated on a 0.25 x 0.25 gridded surface across Australia over the period 1970-2003. Projected changes in rainfall and potential evaporation for 2030 and 2070 are derived from two global climate models driven by scenarios of increasing greenhouse gases. These projections are applied to the observed data and the drought indices recomputed. Widespread increases in drought intensity, frequency and length are likely in the coming decades.

Keywords: drought, australia

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1206**

Occurrence and severity of droughts in the Alpine region: past and future

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In many areas of Europe the summer 2003 heat wave has been unprecedented with respect to the temperature anomaly. In the Alpine region, on the other hand, the ecological impacts of the associated drought have not been as dramatic as, for instance, during the summer of 1947. Why? How did the 2003 drought differ from previous episodes? What are the ingredients that determine drought severity? How will the occurrence and severity of droughts in the Alpine region change as a consequence of global warming? These and other questions are addressed in this contribution, which examines drought characteristics from the point of view of the impact on terrestrial ecosystems, providing an historical perspective and an outlook into the 21st century.

Keywords: droughts, ecosystems, impacts

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1207**

Po River droughts: an evidence of solar-driven hydrological variability?

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Pietro Traverso, Mario Tomasino

A spectral analysis carried out on monthly discharges of the Italian Po river (latitude 45 North) as well as on monthly precipitation rates and evapotranspiration rates over its catchment area acquired since 1831 suggests that the local hydrologic variability is strongly influenced by solar activity, this relation being particularly evident during the last 80 years. In particular, the fundamental solar-type oscillatory modes at O(8) year (solar torque cycle), O(11) year (Schwabe cycle) and O(22) year (Hale cycle) are found to be strongly associated to discharge variability. The correspondence between synchronic dryer-warmer (wetter-colder) periods in the area and positive (negative) phases of the North Atlantic Oscillation, which are driven by strong (weak) solar activity associated to O(8) year periodicities, provides additional support to a scenario in which solar activity constitutes a major forcing of the regional climate of Northern Italy at interannual to decadal time scales. In particular, this contribution shows that the apparent progressive solar-driven depletion of basin reservoirs observed since 1920, i.e., when concomitant sudden changes (regime shifts) occurred in precipitation (downward shift) and evapotranspiration (upward shift), is amongst the likely causes of the fact that prolonged drought periods as those observed in the 1940s and, more recently, since 2003 are not observed before 1920, when accumulation of reservoirs occurred.

Keywords: solar activity, po river, reservoirs dynamics

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1208**

Dominant patterns of atmospheric blocking activity associated to meteorological and hydrological drought in Southern part of Romania

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Norel Rimbu

The statistical relationship between the leading modes of precipitation and stream-flow variability recorded at several meteorological and hydrological stations from southern part of Romania and atmospheric blocking over the Euro-Atlantic region is investigated using two-dimensional blocking indicators. The analysis is performed separately for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) for 57 years, between 1948 and 2005. The results indicate that during winter, both hydrological and meteorological drought is associated with enhanced occurrence of blocking-type high pressure systems in the Euro-Atlantic region. Relatively low blocking activity in this region together with enhanced blocking activity near Greenland are associated to high precipitation and river discharge in the southern part of Romania. The blocking patterns associated to high (low) precipitation and stream-flow in this region resemble those associated to the positive (negative) phase of the North Atlantic Oscillation, consistent with our previous results (Stefan et al., 2004). A similar analysis for spring, summer and autumn seasons reveals that meteorological and hydrological drought in the southern part of Romania is strongly connected to blocking activity over Scandinavian region.

Keywords: blocking, drought, precipitation

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1209**

A Paleo-Perspective on Western North American Drought

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Western North America is perhaps unique in having many high-quality climate proxy records covering the pasttwo millenia and in possessing aclimate in which large-scale winter half-yearcirculationvariability plays suchthedominant role in determining local moisture budgets. Not surprisingly, the mostdramatic aspect of the late Holocene climate variabilityfrom this region arethe swings into and out of droughtand the associated marked changes in environmental conditions.Whileepisodes of regional drought punctuate western North American proxy records throughout the lateHolocene,the most widespreadperiod of general aridity occurred during Medieival time. This"Medieval Climate Anomaly" and theless persistentdroughts of more recent centuries have been examinedfrom manyperspectives in studies using biological and geological proxydata, archeological records, and by extrapolating knowledgo of climate relationshipsthrough analogy, statistical approachesor numerical models.Thepresentation will attempta review of the evolution of thecore ideas relating to late Holocene western North America droughtfrom proxy records and insights developedearly on,through the recognitionof widespread Medieval drought, to recent work including large-scale syntheses and paleo-modeling experiments.

Keywords: drought, north america, late holocene

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1210**

The contribution of landatmosphere coupling to recent European summer heatwaves

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Sonia Seneviratne, Daniel Lthi, Christoph Schr

Extreme heatwaves such as in the European summer 2003 highlight the importance of land-atmosphere coupling for the continental-scale summer climate. Most of the recent European summer heatwaves have been preceded by a pronounced precipitation deficit. The lack of precipitation and the associated depletion of soil moisture result in reduced latent cooling and thereby amplify the summer temperature extremes. In order to quantify the contribution of land-atmosphere coupling, we conduct regional climate simulations with and without land-atmosphere coupling for four major summer heatwaves in 1976, 1994, 2003, and 2005. For each event, two simulations are performed using the regional climate model CHRM: One simulation with interactively coupled land-atmosphere processes and another simulation where the soil moisture evolution at each time-step is prescribed by the climatological mean field. To ensure an optimal representation of the continental-scale atmospheric circulation, all simulations are driven with lateral boundary conditions and sea-surface temperatures from the ERA-40 reanalysis (for 1976 and 1994) and from ECMWF operational analysis (2003 and 2005). The evaluation of the experiments reveals that land-atmosphere coupling plays an important role for the evolution of the investigated heatwaves. During all simulated events soil moisture-temperature interactions increase the heatwave duration and account for typically 50-80% of the number of hot summer days. The largest impact is found for daily temperatures extremes during heatwave episodes. Furthermore, drought conditions are revealed to influence the tropospheric circulation by producing a surface heat low and enhanced ridging in the mid-troposphere, suggesting a positive feedback mechanism between land surface, continental-scale circulation and surface temperature.

Keywords: heatwave, land atmosphere coupling, drought

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Oral Presentation** **1211**

Future Mid-latitude Summer Drought: Contrasts between North America and Europe

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Many models predict that summer rainfall will decline over northern mid-latitude continental regions due to anthropogenic forcing. It is known, however, that this result is more robust over Europe than over North America, and it is the aim of this study to better understand the reasons for this important regional difference. This contrasting uncertainty is illustrated using data from both the IPCC-AR4 multi-model ensemble and the Met Office Hadley Centre perturbed physics ensemble in which modelling uncertainties are systematically sampled by perturbing uncertain parameters. In both ensembles the summer rainfall decline is more robust over Europe primarily because of a difference in the mean (rather than the spread) of the PDF of future-minus-present rainfall anomalies. Previous work has shown that the decline of projected European summer rainfall is driven by a combination of (a) an earlier and more rapid decline in soil moisture during spring, and (b) an enhanced summer landsea contrast in surface warming, leading to reduced relative humidity in air advected onto the continent. Large-scale atmospheric changes, including teleconnections from remote regions, play a much smaller role. The relative importance of these mechanisms is compared between the two continents, using data from the perturbed physics ensemble, which in this case consists of 66 different versions of the HadCM3 model. Further contrasts in mechanisms of the rainfall decline are also found between the mountainous western part of North America and the eastern part which is more directly upstream of tropical climate anomalies.

Keywords: anthropogenic, drought, america

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JMS015 **Oral Presentation** **1212**

An Ingredients-Based Approach to Drought Mechanisms

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Summertime precipitation in the southern United States is a consequence of moist convection. To understand the causes of summer drought in the southern US, we adopt techniques previously applied to forecasting convection and severe weather, by first identifying the necessary ingredients for convection, determining the ingredient(s) most responsible for interannual variabiity, and proceeding along the chain of causality in this manner. Of the factors controlling convection, the most important modulator of monthly precipitation variability is convective inhibition, or CIN. CIN, in turn, is almost entirely determined by surface dewpoint and 700 hPa temperature, which are nearly independent of each other. Surface dewpoint, in turn, is strongly affected by soil moisture, providing the mechanism for feedback of drought. The temperature aloft is largely determined by the extent to which the air has experienced heating over the elevated Altiplanicia Mexicana and the southwestern United States. The development of a localized upper-level ridge favors such transport, and also suppresses disturbances in the area.

Keywords: drought, ingredients, convection

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JMS015 **Oral Presentation** **1213**

On the hydrological drought event in the Danube lower basin in 2003 and possible signals of the atmospheric and oceanic variability

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In 2003, Romania was situated at the periphery of blocking high-pressure system associated with heat wave nucleus, and 2003 summer was very hot and it was exceeded only of summer 1946. In this study the monthly mean discharge level in the Danube lower basin during 2003 is analysed. For this purpose the Orsova station with the longest observation time series (since 1840), situated in the south-western part of Romania was considered as representative in this analysis. In January and February, discharge level was situated a little above multiannual mean. Beginning with March, discharge level has been decreasing until October, when a slight increase was observed but this has remained situated also below normal up to December. In comparison with multiannual values, monthly mean of discharge in July and August 2003 reached the absolute minimum for respective months from the observational period (1840-2003). In June and September the second minimum was recorded, after absolute minimum occurred in 1993 and 1947, respectively. This extreme event affected natural ecosystems, agriculture, water supply, energy demand, navigation, etc. In this study are presented the results of the teleconnections between discharge level in the Danube lower basin and atmospheric circulation over Europe, Sea Surface Temperature Anomalies (SSTA) from tropical Atlantic, indices which defined North Atlantic Oscillation (NAO) and El Nino Southern Oscillation (ENSO). In order to find the atmospheric circulation influence over Atlantic European region on the occurrence of extreme events in the Danube lower basin, the period 1958-2001 was analyzed (ERA-40). The observed monthly fields for Atlantic European region (30-65N; 50W-40E) are: Sea level pressure (SLP); 500-1000 hPa thickness; 500 hPa geopotential. The teleconnection analyses have been made between monthly mean values, using as predictand the discharge level of the Danube lower basin (Orsova), and as predictors the first 10 components (86% of total variance) from Multivariate Empirical Orthogonal Functions (MEOF) decomposition of the above three fields or as predictors the time series from each grid point where the atmospheric fields are defined. For the series of monthly discharges, in the case of the 10 predictors, using a multiple linear regression, the most significant results from statistical point of view, have been obtained in the case of one-month lag, meaning that the atmospheric circulation over Europe at moment t is a good predictor for the Danube lower basin discharge at moment t+1. For the particular case of the months June, July, August and September, the best result was obtained for discharge level in September taking into account the state of atmospheric circulation at 500 hPa in August. The key zone at 500 hPa is centred about 45 N and 10 E. The test of the SSTA signal (filtered by the first EOF) in the atmospheric circulation over Europe or direct in the discharge level in the Danube lower basin has been achieved by means of teleconnection analysis with the lag from 1 to 12 months. The SSTA from tropical Atlantic (22.5 N-22.5 S; 67.5 W-12.5 E) were kindly provided by British Atmospheric Data Centre (BADC) for the period 1950-2000. From the analysis of outputs, it has resulted that the first PC of EOF decomposition of SSTA with approximate 6-month previous is a good predictor for the atmospheric circulation over Europe . For the region in the 500 hPa which might be considered a signal for discharge level, the key zone and predictor months in the tropical Atlantic have been also identified. The SSTA from January and February can be considered that have a signal in atmospheric circulation over Europe in August. In its return atmospheric circulation over Europe in August influences the state of discharge in September. In order to reveal the NAO and ENSO signals on the discharge level in the Danube lower basin, the teleconnection using relative long time series (> 100 years) was tested. The

ENSO was quantified both by SOI and TNI. For the long period, the NAO from winter time (averaged over December, January, February and March) is a good predictor for discharge level during the spring and early summer. Related to the four months, with exceptionally drought in 2003, the statistical significant results (95% confidence level) for a short series only from 1970 have been obtained for NAO in January, February and March as predictors for discharges in June, August and respectively September. The ENSO signal is generally weak. We have not found any signal (with confidence level higher than 95%) of ENSO quantified by TNI for the four months. The SOI values in March and April can be considered as predictors for discharge level in August. The investigations considering complex indices which combine general factors at planetary scale with the indices that define the characteristics of local regional (local) factors lead to improvement of the results referring to the prediction of the discharge level in the Danube lower basin.

Keywords: teleconnection, extreme, drought

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JMS015 **Oral Presentation** **1214**

The influence of large scale atmospheric circulation on drought variability in Central Europe

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This contribution analyses the relationships between drought variability in Central Europe and corresponding large scale atmospheric circulation variations in the period 1957 to 2000. Temporal variations in Central European drought severity are estimated by calculating monthly standardized precipitation indices (SPIs) on the basis of 0.5 by 0.5 gridded monthly precipitation sums from the global VASClimO data set covering the period 1951-2000. The SPI is calculated for varying time scales ranging from 3 to 24 months thus quantifying different types of drought events.Major North-Atlantic-European circulation types are derived by applying an objective circulation classification scheme to daily 1.0 by 1.0 gridded MSLP-fields over the domain 30.0 - 76N and 37W 56E available from the ERA40-Reanalysis data set for the period 1957-2002. Temporal variations of the resulting 18 circulation types may be described in terms of their frequency time-series and as well in terms of their varying internal characteristics including dynamic (e.g. relative vorticity) and climatic indices (e.g. type-related rainfall).The relationships between spatio-temporal SPI variations on the one hand and the large scale atmospheric circulation on the other hand are assessed in a first step by Spearman rank correlation coefficients between time series of SPI and frequency as well as within-type properties of individual and aggregated circulation types, respectively. Further studies, still in a preparatory state, will focus on multivariate analyses of Central European dynamics of drought.

Keywords: drought, circulation types, central europe

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JMS015 **Oral Presentation** **1215**

Future changes in European summer climate: mechanisms and implication for the hydrological cycle over France.

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Mid-latitude droughts involve complex regional processes, linking both the energy and hydrological cycle and are associated with complex retroactions. Climate change scenarios from IPCC-AR4 models generally agree on a strong diminution of precipitation on Mediterranean Europe associated with an important increase of temperature. Nevertheless, the magnitude of the changes are substantially different. The coarse scale resolution of most coupled climate model may be problematic in this context as important regional biases concerning for example precipitation or soil-moisture may exist due to the poor representation of regional physiographic features. First, an ensemble of four climate simulations for the 1950-2100 period using the global ARPEGE atmospheric model in a variable resolution configuration is analyzed. The model resolution is maximal over the Mediterannean sea and remains inferior to 60 km over most of the European territory. This model is suitable to consider both changes in large scale circulation as it is global and regional processes over Europe. In these simulations, the ARPEGE model is forced by greenhouse gazes and sulfate aerosols concentration from the sres A1B scenario for the 2000-2100 period (observations for the 1950-2000 period) and by the corresponding sea surface temperature (SST) derived from a low-resolution coupled model simulation (CNRM-CM3 model from IPCC AR4 archive). Different mechanisms may be implicated in the changes of summer European temperature and precipitation (Rowell, 2006). Soil-moisture may be involved through decrease during spring due to enhanced evapotranspiration, and/or positive feedback during summer. Changes driven by large scale circulation or global atmospheric warming may aslo play a role. This framework is considered to analyze the changes in the regional climate scenario during summer over Europe and the intra-ensemble variability. The changes seen on the surface energy budget, temperature and precipitation are coherent with soil-moisture mechanisms but large scale circulation changes have also an impact. Next, the results from an hydro-meteorological simulation over France forced by bias corrected results of an ARPEGE member on the 1950-2100 period are used to show the great impacts that changes in the regional climate may have on large french river discharges during summer. Finally, the results of IPCC AR4 models are considered given the mechanisms found in our regional climate scenario. The changes in European climate simulated by our simulations are also compared to those obtained in the IPCC AR4 scenarios.

Keywords: droughts, regional, changes

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JMS015 **Oral Presentation** **1216**

Aspects of summer droughts in Europe during 1958-2002

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ERA-40 precipitation, downwelling radiation and near-surface meteorology were used to force the land-surface model TESSEL for the period 1958-2001 over Europe. Monthly averaged hydrological and radiative surface fluxes were used to investigate summer droughts during this period. Anomalies were studied for four different indicators: i) accumulated precipitation; ii) ratio of evaporation over precipitation minus runoff; iii) evaporative fraction; and iv) total depth soil moisture.Drought summers were defined when at least twenty five percent of Europe was under a certain threshold. The thresholds, for each anomaly, were established so that at least ten drought summers could be identified. This analysis, allowed the identification of six drought summers (present in the four analyzed anomalies): 1959, 1964, 1976, 1989, 1990 and 1994. The thresholds were established empirically; however, the minimum spatial coverage requirement and coherency in the identified summers indicate a robust classification.Drought summers were characterized by the affected area and spatial extension; the variety of indicators used illustrate hydrological, meteorological and agricultural aspects of drought. The preceding seasons (for each dry summer) were also analyzed to assess the temporal evolution and possible precursors of summer anomalies. A better understanding of past droughts phenomena is a key factor in assessing future impacts of climate change.

Keywords: drought, reanalysis, hydrology

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JMS015 **Oral Presentation** **1217**

The effects of soil water conditions on the ECMWF seasonal forecast skill

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The European summer of 2003 and the Iberian drought in 2005 are used as case studies to investigate the predictability related with land surface in the ECMWF seasonal forecast system. The large uncertainties in the soil moisture analysis and the atmospheric response to soil water conditions are discussed.

Keywords: soil water, seasonal, forecast

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JMS015 **Oral Presentation** **1218**

ERA-40 hydrological applications of drought analysis over the Iberian Peninsula

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The land surface model TESSEL was forced with ERA-40 during 1958-2001. Soil moisture output was used for drought identification and to create a drought index. A verification of the concept was performed over the Iberian Peninsula, where the derived drought index was compared to other indices in use for agricultural and hydrological purposes, such as the standardized precipitation index (SPI) and the Palmer drought severity index (PDSI). Since precipitation is the major drought atmospheric forcing, a validation of ERA-40 precipitation fields against observations was conducted over Iberia. Despite a dry bias in the rainy season, ERA-40 monthly precipitation explained variance is of the order of 90%, and the 3-, 6- and 12-months SPI are very similar to those from observations. Normalized total depth soil moisture (NSM) is used as a drought index and compared with the SPI, at several time scales, and the PDSI. The high degree of coherency between the three indices for the 44-year period studied is an indication that NSM can be used as a robust drought indicator. Besides the identification of major drought periods and their intensity, soil moisture was applied to the study of drought spatial and temporal patterns over Iberia. The temporal evolution of soil moisture is related to the accumulated precipitation at various time scales, demonstrated with the correlations of NSM and SPI. PDSI and NSM are related since both indexes are associated with the surface hydrological budget. Soil moisture relaxation times were used to identify areas with longer drought periods (due to scarcer annual precipitation values) where NSM is related to SPI at longer time scales. Drought spatial patterns over Iberia were established from principal components analysis. The spatial heterogeneity of precipitation is the main issue in the spatial analysis of drought, while the spatial distribution of the soil physical characteristics plays a secondary part in the spatial analysis, but is important in the temporal analysis. The approach to drought analysis used here can be applied to other areas with realistic time variability of ERA-40 precipitation, with no particular model calibration. Forcing from a future near-real time continuation of ERA-40 could be used as a tool in the monitoring of drought situations. Robust early identification of an impending drought could be used to support drought mitigation actions.

Keywords: drought, era 40, pdsi

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JMS015 **Oral Presentation** **1219**

The role of Mediterranean SST in enhancing the European heat wave of summer 2003

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During Summer 2003, Europe was affected by one of the driest and most persistent heat waves. During this event, the Mediterranean sea surface temperature (SST) was exceptionally warm (SST anomalies of 2-4 Celsius Degrees). Using data from observations and results of model experiments, we investigated the possible role of the Mediterranean SST in enhancing the amplitude of the heat wave. Several Atmospheric General Circulation Model (AGCM) sensitivity experiments were conducted with and without Mediterranean SST anomalies. The AGCM of the Center for Ocean-Land-Atmosphere Studies (COLA) was used for this purpose. First it was found that the AGCM was able to simulate the evolution and structure of the heat wave using observed global SST anomalies, suggesting that the main features of the heat wave were potentially predictable. The experiment with SST anomalies over the Mediterranean only was also able to simulate the upper level anticyclone over central Europe, even though it was weaker, and about half of the amplitude of the heat wave of the global SST anomaly experiment. This suggested that the Mediterranean SST was responsible for more than half of the amplitude of the global SST effect.

Keywords: heatwave, extreme, temperature

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JMS015 **Poster presentation** **1220**

Tree-ring reconstruction of hydrothermic index for AD1680-2005 in Near-Issikl region, Kirgiz Republic

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New regional ring width chronology of spruce (Picea Schrenkiana Fish. et May.) (AD1680-2005) includes 80 samples collected at the lower tree limit in the Issik-Kul lake region in 2001-2005. As soon as the age of the trees at the lower tree limit rarely exceeds 100 years, we used the wood from old buildings (late 19th-early 20th century) to extend the chronology. The low precipitation and high temperature during the warm season limit the growth at the lower tree limit; this allows the reconstruction of hydrothermic index for the last 324 years. The best fit model includes the sum of June-September precipitation of previous and current years divided to the average monthly temperature of the same period. The reconstruction accounts for 41% of the variance in observed hydrothermic index over 18961988. However the correlation between the reconstructed and observed hydrothermic index decreases after 1960s though it is still statistically significant. A possible reason for this decrease is the increase of summer temperature and length of growth season occurred in the Tien Shan Mountains in 1960s and continuing up till now, and consequently a change of response factor. According to this reconstruction the droughts in the Issik-Kul region occurred in 1742-43, 1774-75, 1828-29, 1856-57, 1873-74, 1879-80, 1884-85, 1894-95 and 1916-17. Two last drought periods are confirmed by instrumental data. The longest droughts occurred in 1768-69 /1774-75 and 1741-42/1748-49. In general the 19th century was drier that the 20th century in the Issuk Kul region. The 20th century does not look unusual in the last three hundred years in terms of drought frequency and severity.

Keywords: drought, tienshan, dendroclimatology

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JMS015 **Poster presentation** **1221**

Monitoring of drought severity using GIS in Iran

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Drought is perhaps the most complex natural hazard. It is often generally defined as a temporary meteorological event that stems from the lack of precipitation over an extended period compared with some long-term average condition (e.g. precipitation). But droughts develop slowly, are difficult to detect and have many facets in any single region. The success of drought reparedness and mitigation depends, to a large extent, upon timely information on drought onset, progress and areal extent. These types of information may be obtained through drought monitoring. Monitoring is normally performed using drought indices. Drought Severity Idex (DSI) provides decision makers with information on drought severity and can be used to trigger drought contingency plans, if they are available. This paper calculated DSI for drought monitoring in the Kordestan Povince of Iran. In addition, established regression relationship between mentioned factor and DEM for region classification using GIS technique. The results show that, extensive drought severity was occurred in station which was located in low-level region. Sanandaj station has the lowest elevation in region under study and drought severity is extensive for it. Therefore, Drought Severity is associated with elevation.

Keywords: precipitation, droughtseverityindexdsi, gis

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JMS015 **Poster presentation** **1222**

The Rainfall Enhancement Programme against the Worst Drought in Sichuan

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This paper provides an introduction to the rainfall enhancement programme against the worst drought in Sichuan. Sichuan is a beautiful province in Southwest China, which boasts her agreeable climate and comfortable environment. However, in her rainy season in 2006 this province had been plagued by repeated heat waves and severe wide droughts. In July the month-average temperature of the province was 2.4 degrees centigrade higher than that of 30 years average, and in August 2.9 degrees centigrade higher, which was the highest since 1961. In mid August, the daily extreme temperatures of most areas of the province exceeded the highest temperatures in history since the fist meteorological records in 1951, some of which exceeded 40 degrees centigrade. The month ground-gauged precipitations of most areas of the province were below 200 mm in July, some of which was below 100 mm. The average month ground-gauged precipitation of the province was 83 mm in August, which was the second least since 1961. In July, droughts happened in 40 counties around the province, and droughts in 34 counties were persistent till July 31. Durative high temperature weather above 30 or 35 degrees centigrade happened around most areas of the province since July 11. And droughts spread widely in most areas of the province in August. Till Aug. 11, droughts had happened in 65 counties, droughts in 58 counties were persistent, and 62 counties were drawing near droughts. Great losses damaged every discipline of the society from agriculture, industry, to everyday life. Then the Rainfall Enhancement Programme was commenced in Aug. 12 in the province. The programme was conducted by the Weather Modification Office of Sichuan Province (WMOSP) and funded by the Sichuan Province Government. 82 operational engineers and managers, 1906 subordinate operational jockeys implemented the programme with the aid of the meteorological staff. The telecommunicating video consultation meetings on cloud-seeding times were held every morning from August to September jointly by National Climate Center, National Meteorology Center, National Satellite Meteorological Center, WMOSP, Sichuan Meteorological Station and Chongqing Meteorological Station. In addition, the telecommunicating video meetings on cloud-seeding times were held jointly by WMOSP, Sichuan Meteorological Station, the subordinate meteorological stations and weather modification offices of 20 cities every afternoon. Moreover, WMOSP and the subordinate weather modification offices, operating spots ran all day and all night, communicating through LOTUS NOTES, faxes, radio transmitters, telephones and mobile phones. In addition to routine meteorological observations, 4 Doppler radars, 12 polarization radars, satellites, light locating networks, and raingauge networks were employed in the programme. Cloud-seeding potentials were predicted by synoptic diagnoses, model simulations, and satellite retrievals. Seeding clouds were determined by radar observations. Evaluations were completed with images, words, and data by statistical tests and physical tests. Ground-based cloud seeding operations were conducted in 112 counties across the province. 380 artilleries and 102 rocket-launchers were employed during the emergency time from Aug. 12 to Sept. 5. 11593 artillery shells and 2233 rockets were launched in 1424 operations. There were four types of rockets in use in the programme, which were BL-1, WR-98, WR-1D, and JFJ. And 1173 JFJ rockets, 1060 BL and WR rockets were launched. Silver iodide was introduced as seeding material with specific pre--ions, which was respectively 1 g silver iodide per artillery shell, 3 g per JFJ rocket, 10.5 g per BL-1 rocket, 10 g per WR-98 rocket, and 11 g per WR-1D rocket. And silver iodide was released in clouds by specific generating types, which were explosive for artillery shells, JFJ rockets, BL-1 rockets, and flare for WR-98 rockets, WR-1D rockets respectively. In

and after most operations, the raingauge networks showed that the target regions gained significant rainfall, radars tracked larger and stronger echoes. As a result, droughts in most areas of the province ameliorated or vanished till Sept. 5, although droughts in 10 counties were persistent. The programme showed considerable socio-economic benefits. Furthermore, it is recommended that further development of the technology of cloud-seeding evaluations, more strict operation designs, and more detailed measurements should be greatly emphasized.

Keywords: drought, cloud seeding, operation

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JMS015 **Poster presentation** **1223**

Definition of meteo-climatic scenarios for regional impact of climatic changes: an example from Northern Italy

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Climatic charateristics of Lombardy region (Northern Italy) make this area unique in Europe, as far as territory and environment are concerned. Infact the morfological features of the regional territory (approximately 50% in mountain area, 40% in plain area), the presence of an important lake (Como Lake,146 km2) and high density of population (nearly 9 million people) emphasize extreme meteorological events linked to Global Climatic Change. The climatic variability and the sensitivity of this region to signals of change are clearly defined in the spatial-temporal analysis of temperature, snowfall and rainfall examined within the RICLIC-WARM Project (Regional Impact of Climatic Change in Lombardy Water Resources: Modelling and Applications). Seventy meteorological stations are considered, covering an area between the Ticino and Oglio rivers (more than 60% of regional surface). Analysis of historical meteorological datasets (1951-2003) has shown the main climatic trends and underline dry and wet periods, following mainly the NAO seasonal index, and register the main critical meteorological events. The CLIVAR indices (frosty days FD0, icy days ID0, tropical nights TR, summer days SU, dry CDD and wet periods CWD ecc..) have made the role of meteorological impact evident on available water resources in Lombardy and the importance of rational management. Indices put in evidence anomaly periods that are used to define possible scenarios (for example the summer heat wave of 2003). These meteorological scenarios are used as base for the socio-economic analysis, in order to describe the most relevant drivers of the study area, from a social and economic point of view.

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JMS015 **Poster presentation** **1224**

Towards the forecasting of regional drought in France

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The paper describes a method to forecast regional drought in France and presents preliminary results based on 121 river flow stations with data between 1961 and 2004. The method used was modified from earlier work in Europe (ARIDE project) where forecasting potential was found to be acceptable. Calibration was done on the 1961-2000 period, reserving 2001-2004 for the evaluation. Regional drought is defined here as the extent of exceptionally low flows through the Regional Deficit Index RDI. The method used is divided in three separate steps. First, regions are established based on the simultaneous occurrence/ non occurrence of flow deficits (flows lower than Q90(t), the 90th percentile for the station at that time of the year). Using a partitioning technique based on the Wards algorithm, six regions were defined. Spatial coherence of the regions and stationarity were verified by separate clustering analysis on three periods (1965-2000, 1965-1990 and 1975-2000). Coherence in the monthly river flow regime of each region was also verified. Second, for each region, the circulation patterns of the Hess-Brezowsky Grosswetterlaggen European classification were categorised in eight or four groups according to their association with wet or dry days. Rainfall data of 25 locations were used. This method is a modification from earlier work that based the Weather Pattern (WP) categories uniquely from flow deficit occurrence. Third, RDI, which is the proportion of stations in the region at time t with discharge below Q90(t), was modelled in two stages, using a basic recursive process. The first stage involved the modelling, every day, of the change in the drought extent (i.e. increase/ decrease of the proportion of the region under deficit) depending on the WP occurring that day. The second stage derived RDI from the computed change in the drought extent and the value of RDI the previous day. A sequential algorithm was used to evaluate the objective function (Pearson product coefficient) for a large number of parameter set combinations, the final set maximising the objective function. Sensitivity analysis showed that results remain acceptable when four WP categories are considered instead of 8, significantly reducing the iterative calibration. WP categories based on seasonal rainfall patterns instead of annual pattern did not improve the results. Mountainous regions showed the worse results, that could be due to the exclusion of temperature data in the WP categorisation. Regional differences were found in the performance of the models for the independent evaluation period 2001-2004. However, all models in all regions predicted reasonably well the occurrence of the summer 2003 drought, but not its intensity. Models based on rain-clustering of WP proved more robust than RDI-based groups.

Keywords: forecasting, drought, circulation patterns

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JMS015 **Poster presentation** **1225**

The Relation Between Drought and Dust Storm in Southeast Iran

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The southeast of Iran is considered as one of the major regions of dust and sand storm activities in the country. In this research, the data elements for temperature, precipitation, and dust and sand storm obtained from synoptic stations throughout the province has been analyzed by the utilization of statistical methods. The results demonstrated the trend and changes of such parameters and also their relation with each other. During the period of 1951-2003 years, the temperature, and in particular, the minimum temperature of the region has increased. The number of frost days has been decreased, but the change in the pattern of precipitation has conformed to the international patterns. Moreover, the number of days with dust and sand storm has had significant trend and changes. In general, the stations with the increasing trend in the number of dust and sand storm days, have witnessed the highest number of annual and seasonal (spring and winter) stormy days during the 1998-2003 drought period. Obtained outstanding results from 11 stations data analyze show that most of stations had a higher frequency for the interval between years 2000 and 2003.

Keywords: dust and sand storm, drought, southwest of iran

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JMS015 **Poster presentation** **1226**

Effect of soil drought to evapotranspiration on semi-arid grassland in Mongolia

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Mongolia territory, locating in semi-arid at mid-latitude, is covered dominantly by grassland more than 80%. Drought has been a recurrent problem in Mongolia which border on the northern Eurasia cryosphere. PDSI analysis reveals drought occurred in the region since 1965. Especially both during 1967-72 and 1995-2002, continuously summer drought altered human being inadvertently in Mongolia. On such semi-arid grassland, land surface is anticipated directly to affects the atmosphere at the local to regional scale primarily through the energy and water vapor transferred to the atmosphere. These fluxes are governed most strongly by vegetation and surface moisture and therefore are extremely sensitive to changes in terrestrial hydrologic processes. Since July 2002, intensive observation, including micrometeorology, phenology, heat budget and soil heat/water condition, has been conducted at site on sparse grassland in Mongolia. In this work, variability of evapotranspiration was investigated by assessing to soil water status. The parameterization of soil evaporation using soil surface moisture provide useful tool to partitioning soil evaporation and transpiration to evapotranspiration. Verification by micro-Lysimeter observation on calculating soil evaporation and evapotranspiration shows the partitioning was reasonable in study region. The seasonality of evapotranspiration on such semi-arid sparse grassland was briefly straiten by soil moisture relating snow melt and precipitation events. In the observation period from July 2002 to June 2004 consisting two cycle of cross pre-growth to senescence period, partition of transpiration was 22%. Corresponding to heat fluxes seasonality, evapotranspiration sensitive to precipitation (ground surface moisture). Ratio of transpiration to evapotranspiration was averaged to be 14% in the moister grass-growing period of 2003, but was 38.5% in drier early-growth of 2004 and was 40.9% in drier peak growth of 2002, which is anticipated to determined by high leaf conductance in drier period and lower leaf-to-air specific deficit in moister period. During soil drought events, the magnitude of the decrease in transpiration by phreatophytes typically is slight because they are deep rooted and obtain their water from near the water table rather than from the overlying soil zone. By employing PDSI and remote sensing based model, interannual variability of evapotranspiration is investigated using in-situ meteorological data and NDVI data.

Keywords: evapotranspiration, soilmoisture, grassland

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JMS015 **Poster presentation** **1227**

Recent trend of dry spells in Isfahan Province, Iran

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In this study the time series of annual maximum dry spells and the annual number of dry spells of Isfahan Province were analyzed in order to investigate the existence of trend by the use of Mann-Kendall test. The selected time series were first tested for homogeneity by the use of run test. Results indicated statistically homogeneity at 95% significant Level. The results of trend analysis showed that only 2 stations have significant decreasing trend of the annual maximum dry spells at the significant level of 5%. The results also showed 3 stations with increasing trend in the number of dry spells and 1 station with decreasing trend in the number of dry spells which are significant at 5% and 1% significant level.

Keywords: mid latitude, droughts, changing climate

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JMS015 **Poster presentation** **1228**

Mid-latitude droughts in a changing climate, a case study of drought frequency analysis in upper Benue Basin North-Eastern Nigeria.

Mr. Abubakar Mu'Azu
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The paper presented here gives a statistical analysis of rainfall records for 6 primary stations in Upper Benue Basin, North Eastern Nigeria. These include the probability of occurrence of lower rainfall figures with return periods; 10, 20, 30, 50, 100 and 1000 years. Runoff data for Benue river at (Jimeta) Yola and Gongola river at Dadin kowa , also in North Eastern Nigeria, were analyzed for low annual flow with return periods; 10, 20, 30, 50, 100 and 1000 years, using weibull probability equation. From available records it is evident that drought has occurred in the Upper Benue basin during 1944, 1950, 1956, 1959, 1961, 1966, 1974, 1977, 1983, 1984, 1987, 1990, 1991. The entire catchment area of the basin from the southernmost location Gembu on the Mambila plateau lat. 6o41N; long. 11o17E to Dadin kowa lat. 10o18N; long11o45E; Gassol lat. 8o31N; long. 10o28E; Yola lat. 9o18N; long. 12o28E.

Keywords: drought, frequency, analysis

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS015 **Poster presentation** **1229**

Changes of extreme dry conditions in spring-summer for mid-latitudinal regions of northern Eurasia from observations, reanalysis and model simulations

Prof. Igor Mokhov
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Alexander Chernokulsky, Igor Shkolnik, Vladimir Tikhonov

Data from observations and ERA-40 reanalysis are used for analysis of extreme dry conditions for summer and spring months in the Northern Eurasia during the 20th century and the beginning of the 21st century. Different indices for the drought and forest fire conditions are analyzed with an assessment of effects of El-Nino phenomena. Changes of anomalous dry regimes in the 21st century relative to the end of the 20th century for European and Asian regions in middle latitudes are analyzed also with the use regional model simulations with anthropogenic scenarios.

Keywords: droughts, fires, climate

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JMS015 **Poster presentation** **1230**

Changes in extreme precipitation indices in Romania, 1961-2005

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Climate Research National Meteorological Administration IAMAS

Madalina Baciu, Ioana Colfescu

Trends in indices of daily precipitation extremes are studied on the basis of daily series of precipitation from 120 meteorological stations in for the period 1961-2005. A core set of six extreme precipitation indices were selected (90th percentile of rainday amounts (mm/day), greatest 5-day total rainfall, simple daily intensity, max no. consecutive dry days, % of total rainfall from events > long-term P90, no. of events > long-term 90th percentile of raindays). These indices were seasonally calculated with the STARDEX extremes indices software. Trends in an index were calculated by a simple model of least squares fit and trend significance was tested using a Students t test. To better understand how precipitation extremes relate to changes in precipitation climatology, trends of seasonal precipitation totals were also calculated. Major findings arising from this analysis show: widespread significant negative trends of precipitation totals in all seasons except autumn. This characteristic is mostly observed in the south and south-western part of during winter and summer. As for the extreme precipitation the results show that increase of extreme precipitation is observed mostly during spring and summer.

Keywords: precipitation, extremes, romania

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **1231 - 1250**

Symposium
Cryospheric Change and Sea Level

Convener : Dr. Steve Harangozo
Co-Convener : Prof. Konrad Steffen, Prof. David Holland

Major changes have occurred in the cryosphere in recent decades, with Arctic sea ice extent reaching record low values, glaciers retreating in all parts of the world, permafrost disappearing in many parts of the Arctic and snow cover extent reducing. There are also indications that the Greenland ice sheet is decreasing in size with implications for sea level. This symposium invites papers on all aspects of monitoring and modeling the cryosphere, and determining the possible impact on sea level. We welcome papers of sea ice, the ice sheets, snow cover, glaciers, ice shelves and permafrost.

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1231**

The nonlinear response of ice-shelf basal melting to variation in ocean temperature

Prof. David Holland
Mathematics New York University IAPSO

Paul R Holland, Adrian Jenkins

A three-dimensional ocean General Circulation Model is used to study the response of idealized ice shelves to a series of ocean-warming scenarios. The model predicts that the total ice-shelf basal melt increases quadratically as the ocean offshore of the ice front warms. This occurs because the melt rate is proportional to the product of ocean flow speed and temperature in the mixed layer directly beneath the ice shelf, both of which are found to increase linearly with ocean warming. The behavior of this complex primitive-equation model can be explained surprisingly well by an idealized reduced system of equations, and it is shown that the applicability of the reduced system implies a melt rate response to warming that is quadratic in nature. The results of this study confirm and unify several previous examinations of the relation between ice-shelf melt rate and ocean temperature but disagree with others, for which explanations are proposed. Since ice shelves link the Antarctic Ice Sheet to the climate of the Southern Ocean, this finding of an above-linear rise in ice-shelf mass loss as the ocean steadily warms is of significant importance to our understanding of ice-sheet stability and sea level rise.

Keywords: iceshelf

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1232**

Recent ice sheet and glacier elevation changes in Greenland from aircraft laser altimetry

Mr. William Krabill

Robert H. Thomas

The Arctic Ice Mapping group (Project AIM) at the NASA Goddard Space Flight Center Wallops Flight Facility has been conducting systematic topographic surveys of the Greenland Ice Sheet (GIS) since 1993, using scanning airborne laser altimeters combined with Global Positioning System (GPS) technology. Earlier surveys showed the ice sheet above 2000-m elevation to be very close to balance, but with localized regions of thickening or thinning; by contrast thinning predominated at lower elevations. Overall, this resulted in a negative mass balance for the entire ice sheet during the 1990s. More recently, the effects of higher-elevation thickening have been exceeded by increased near-coastal thinning, resulting in a marked increase in total ice loss from the ice sheet. Here, we present results extending the time series of observations to 2007, when critical segments of flight lines over key outlet glaciers are to be re-surveyed.

Keywords: ice sheets, glaciers, airborne laser altimetry

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1233**

Secular trend of the Equilibrium Line Altitude (ELA) along the Southern Andes Mountains derived from radiosonde observations

Dr. Jorge Carrasco
Climatology Direccion Meteorologica de Chile IAMAS

Roberto Osorio, Gino Casassa

An analysis of the air temperature behaviour in the lower troposphere was conducted for the last 35-45 years along the southwestern side of South America using the historical radiosonde data from stations located in Antofagasta (2326S, 7026W, 135 m.a.s.l), Quintero/Santo Domingo (3247S, 7133W, 8 m.a.s.l/ 3338S, 7138W, 77 m.a.s.l.), Puerto Montt (4126S, 7307W, 81 m.a.s.l) and Punta Arenas (5300S, 7058W, 37 m.a.s.l.). A latitudinal altitude profile of the zero degree isotherm (ZIA) was derived from the radiosonde data, as well as it was calculated the latitudinal profile of the annual precipitation. Both profiles were used to determine the changes in the equilibrium line altitude (ELA) along the western side of the Andes Mountains. Results reveal an overall warming of the lower troposphere and therefore a positive trend of the ZIA, which is strongly influenced by the 1976/77 climate shift and it is less significant in the South America. During the last 35-40 years, no significant changes in precipitation occurred to north of ~34S, but a slight increase has been taking place to the south of ~46S; while a significant decline is registered in the annual precipitation between ~34 and ~46S. These atmospheric changes suggest that the retreat and shrink of Andes glaciers in central (southern) Chile mainly respond to the tropospheric warming (to the decrease precipitation).

Keywords: equilibrium line altitude, radiosonde, andes

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1234**

Mass balance of Greenland and Antarctica from spaceborne observations of ice flow

Dr. Eric Rignot
Radar Science and Engineering Jet Propulsion Laboratory, Caltech

Little was known about the mass balance of ice sheets in the early 1990s. This situation has changed considerably with the advent of satellite and airborne techniques. At the same time, significant changes took place in Greenland and Antarctica. We present an overview of what we have learned from interferometric spaceborne radar observations of mass flow. In Greenland, coastal thinning dominates the ice sheet mass balance, and 2/3rd of the thinning is caused by the acceleration of outlet glaciers. The mass budget from the comparison of the mass flux into the ocean with the mass input from snow doubled in the last ten years to reach 200 cubic km of water per year net loss in 2005. Most loss is concentrated in the southeast and central west where climate warmed up considerably since 1980, but other sectors (northwest, south) also contribute. Glacier acceleration is caused by ice-front thinning and enhanced lubrication. In the Antarctic Peninsula, where warming proceeds at 6 times the global average, ice shelves are collapsing, triggering speed up of land-based glaciers, with much larger acceleration than in Greenland. Farther south, there is widespread thinning of West Antarctica along the Bellingshausen and Amundsen seas, caused by the thinning of its buttressing ice shelves from warm ocean waters. As the glaciers continue to accelerate, sea level rise from West Antarctica is increasing with time. In all these regions, the observed trends are already larger than what was predicted by IPCC to occur in the next century, and we do not see any physical reasons why this would stop if climate warming continues. The bigest challenge is to predict how fast these changes will be in the next century.

Keywords: interferometry, glaciology, climatechange

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1235**

The contribution of the atmospheric circulation to the record summer sea ice extent in the Ross Sea in 2002-2003

Dr. Steve Harangozo
Physical Sciences Division British Antarctic Survey IAMAS

In the Antarctic the Ross Sea sector stands out as the only region where sea ice has increased in all seasons of the year since the late 1970s. During the last decade severe ice conditions have even affected the area in summer in several years and, in the most recent case, greatly hampered the re-supply of the U.S McMurdo base. As yet, however, the reasons for this increasing sea ice cover remain unclear. This paper examines recent cases of very extensive summer ice in the Ross Sea in order to identify some of the factors that lie behind the long-term increase in summer ice extent. It focuses mainly on the 2002-03 summer leading up to the greatest February sea ice on record. The evolution of the ice cover will be studied using ice concentration data, and ice motion data will be used to determine how unusual the ice drift patterns were. Atmospheric circulation reanalyses as well as in-situ, e.g. ship, data will also used to investigate ice-atmosphere interactions. Results indicate that strong ice-atmosphere interactions and ice dynamics were crucial to the spring sea ice cover staying intact into the 2003 summer, especially as air temperatures during summer were about normal. In particular, the ice cover was able to stay intact because the ice in the southern Ross Sea was widely compacted during the preceding spring. This compaction arose from northerly winds advecting ice towards the coast over an extended period in the 2002 spring. In fact, the atmospheric circulation was highly anomalous in the 2002 spring. El Nino events appear to be associated with the anomalous atmospheric circulation at this time and in other years of extensive summer ice.

Keywords: antarctic, ross sea, sea ice

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1236**

The role of ice-ocean interaction in the mass budget of the Amery Ice Shelf system

Dr. Ian Allison
Ice, Ocean, Atmosphere and Climate Programme Australian Government Antarctic Division

Michael Craven, Helen Amanda Fricker, Neal Ypung

Antarctic ice shelves, which have their basal surface in contact with circulating ocean water, are the most sensitive component of the Antarctic ice sheet system to atmospheric or oceanic warming. The speed with which changes can occur was demonstrated recently by the rapid collapse of Antarctic Peninsula ice shelves. The Amery Ice Shelf in East Antarctica is the third largest embayed ice shelf, and is located significantly further north (its front is located at ~69S) than the Filchner-Ronne and Ross ice shelves (~77S and ~78S respectively). Compared to these ice shelves it is relatively narrow (decreasing from 200 km width to only 50 km at the grounding zone), but the ocean floor at the grounding zone is greater than 2500 m deep. The "ice pump" circulation in the ocean cavity under the shelf drives a very high melt rate near the grounding zone, and more than 80% of the meteoric ice that flows from the Lambert Glacier basin across the Amery grounding line is lost as basal melt. But there is also a considerable accretion of marine ice that occurs mostly under the north-western part of the shelf. Nearly 40 % of the mass that is lost by melt is re-deposited on the bottom of the shelf as marine ice. Between 2001 and 2006, we have drilled four boreholes, up to 720 m deep, through the ice shelf, and at two of these we found a total thickness of marine ice of approximately 200 m. The lowest 100 m in both holes was unconsolidated and porous, and from hydrostatic calculations we determine that the total marine ice layer at both sites has an average of only 60-70% ice, with the rest of the layer being seawater. From the borehole observations, and data on ice shelf dynamics, we estimate that accretion rates under the north-western part of the shelf are around 1 m/yr. We have deployed multi-year oceanographic moorings through the boreholes into the ocean cavity and these show that there is a very strong seasonal cycle, and considerable inter-annual variability, in the cavity circulation that drives the basal melt and accretion. Comparison of these data with mooring data and hydrographic surveys off the front of the ice shelf shows a strong coupling of processes occurring in the seasonally sea ice-covered ocean in Prydz Bay and in the ice shelf cavity.

Keywords: antarctica, ice shelf, ocean

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1237**

Melt assessment and moulins along the western slope of the Greenland ice sheet

Prof. Konrad Steffen
CIRES University of Colorado IAMAS

Understanding the flow of water through the body of a glacier or ice sheet is important, because the spatial distribution of water and the rate of infiltration to the glacier bottom is one control on water storage and pressure, glacier sliding and surging. According to the prevailing hypothesis, this water flow takes place in a network of tubular conduits. The prevailing view of englacial water flow through tubular conduits is supported by observations of caves on the margins of glaciers and explorations into Moulins (a vertical shaft in a glacier). Whether such features are unique to the margin and to Moulins is unclear. The surface velocity of the Greenland ice sheet varies significantly on both seasonal and shorter time-scales. Seasonal variations reflect the penetration of supraglacial water to the glacier bed through significant thicknesses of cold ice. Shorter-term events are associated with periods of rapidly increasing water inputs to the subglacial drainage system. Early-season short-term events immediately follow the establishment of a drainage connection between glacier surface and glacier bed, and coincide with the onset of subglacial outflow at the terminus. Field studies on the Greenland ice sheet in 2006 and 2007 revealed that the water flow through Moulins close to the margin of the ice sheet has a direct connection to the underside of the ice sheet. These findings are based on in- situ observations of Moulin measured with laser technology, bedrock topography adjacent to the Moulin from ground penetrating radar, and temperature profiles and energy balance modeling for the assessment of the water flow. The characteristics of the Moulins are discussed in relation to ice flow velocity, and ice-bedrock quakes recorded along the margins of the ice sheet.

Keywords: greenland, melt, moulin

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JMS016 **Oral Presentation** **1238**

Future volume changes for six glaciers forced by hypothetical warming scenarios: flowline modelling vs volume-area scaling

Mrs. Valentina Radic

Regine Hock, Johannes Oerlemans

Volume-area scaling is a practical alternative to ice-flow modelling and particularly useful for modelling glacier volume changes on a global scale due to low requirements of glacier geometry data. In order to quantify the uncertainties in volume evolutions derived from volume-area scaling method we compared the evolutions with those derived from 1-D ice flow model. The comparison is performed on six glaciers of different geometry and different climate regimes: Nigardsbreen, Rhone Glacier, South Cascade Glacier, Abramov Glacier, Sofiyskiy and Midre Lovenbreen. We calibrated the ice flow model with historical glacier fluctuations and observed mass balance profiles and then modelled the volume evolutions due to climate warming as prescribed by negative mass balance perturbations on a century time scale. In the scaling method we included the mass-balance elevation feedback by removing elevation bands at the lowest part of the glacier in response to negative mass balance variations. Provided area-changes are considered in the mass balance computations in this way, results indicate that 100-year volume changes from the scaling method differed from those obtained from the ice-flow model by up to 10% for larger glaciers (>20 km2) and 25% for smaller glaciers. We further analyze the differences in terms of the magnitude of the mass balance perturbation and the state of the glacier prior to the imposed hypothetical mass balance perturbation.

Keywords: volume area scaling, volume evolution, ice flow modelling

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JMS016 **Oral Presentation** **1239**

Snow cover changes over Northern Eurasia during the last century

Dr. Raino Heino
R&D FMI IAMAS

HEINO Raino 1. KITAEV Lev 2 1. Finnish Meteorological Institute, Helsinki- Finland2. Russian Academy of Sciences, Moscow - RussiaThe recently completed INTAS-SCCONE project studied trends in snow cover over the Northern Eurasian region during the last century. Because snow extent influences the air temperature through positive albedo feedback, it is important to understand long-term trends. The general objective of the project was to assess the trends, climatic causes and hydrological consequences of the snow-cover changes inNorthern Eurasia during the 20th century. This objective was accomplished by extracting and analyzing historical data that were available to all participating countries. - The duration of snow-cover shows negative trends in western Scandinavia and in the south-west of the East European plain, but mainly positive trends in the remainder of Northern Eurasia . For the larger part of northern Eurasia , the snow-cover duration and snow depth is still increasing despite recent global warming.

Keywords: snowcover, climatechange

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1240**

Arctic Change on the Autobahn

Dr. Jennifer Francis
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Mark Serreze

The only thing that has been constant in the Arctic during recent decades is sweeping change. Observations of almost every aspect of the climate system suggest a cohesive shift toward an Arctic with warmer temperatures and less permanent ice, the most conspicuous indicator being the loss of perennial sea ice. Global climate models have long predicted that the sea-ice-albedo feedback will accelerate the Arctic's response to increased greenhouse gas concentrations, but only recently have observations exhibited signs of this prediction being true. While all forms of permanent Arctic ice are in rapid decline, this presentation will focus on new research that sheds light on drivers of sea ice loss, which appears to have accelerated during the past decade, as well as connections to changes in the atmosphere and model predictions for the future.

Keywords: arctic, sea ice

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1241**

Evidence for enhanced ablation Vs. enhanced accumulation in southern South America: assessing the net balance

Dr. Gino Casassa
Glaciology and Climate Change Centro de Estudios Cientficos

Gino Casassa, Andrs Rivera, Robert Thomas, Eric Rignot

The Northern and Southern Patagonia icefields of southern South America (NPI and SPI respectively) and the Cordillera Darwin icefield (CDI) in Tierra del Fuego are strongly affected by the westerly circulation with abundant precipitation to the west (up to ~10 m/yr water equivalent (w.e.)) and large ablation (>10 m/yr w.e.) in the lower reaches. Glacier fronts typically calve either into freshwater lakes or into fjords. In Patagonia outlet glaciers show a generalized retreat and thinning over the past century, being explained by atmospheric warming (Rasmussen et al., in press) in combination with long-term decreased precipitation, at least until the 1980s (Rosenblth et al., 1995). Based on a comparison of 2000 SRTM data with 1968, 1975 and 1995 cartographic data of Chile and Argentina and a few limited ground survey points, the study of Rignot et al. (2003) has shown an important volume decrease over the last 25 years for the largest 63 outlet glaciers of NPI and SPI, with an accelerated trend in recent years. Thinning is maximum close to the glacier fronts, and decays to near-zero close to the equilibrium line altitude. Due to lack of cartographic coverage in the upper reaches because of limited stereoscopic view in the original aerial photographs of NPI and SPI, the analysis of Rignot et al. (2003) is limited to the lower ablation areas, and no significant changes could be derived for the upper accumulation areas. The available data of frontal changes in CDI shows prevailing glacier advance in the south west and partly in the north west as well, with dominant recession in the east, but no data of ice thickness changes exist to date. In November/December 2002 two flights were made from Punta Arenas by the Centro de Estudios Cientficos (CECS) aboard a Chilean Navy P-3 Orion aircraft, equipped with NASA sensors that included a scanning laser altimeter that yielded measurements of surface elevation to an accuracy of +/- 0.5 m along a total 4000 km flight track over the glaciers, covering most of NPI and part of SPI, both in the ablation and accumulation areas. Preliminary computations of ice thickness changes during the period of 2.8 years between the SRTM data and the laser altimetry data at several glacier basins over SPI and NPI suggest a small but significant thickening trend at the 99% level at upper elevations in the accumulation areas of many glacier basins, presumably in response to recent accumulation increase. At CDI the glacier advance in the west is postulated to be a direct response to recent accumulation increase, while in the east the enhanced ablation due to warming most probably prevails. In spite of the advance of western CDI glaciers, overall the glaciers in Patagonia and Tierra del Fuego are contributing to sea level rise.

Keywords: southern south america, mass balance, ablation accumulation

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1242**

Change of Greenland Ice Sheet due to Global Warming Simulated by SICOPOLIS

Mr. Masahiro Hosaka
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Ralf Greve

The changes of the Greenland ice sheet due to global warming by using a ice sheet model SICOPOLIS are shown. The forcing data were made from the output of 18 state-of-art global climate model simulations. All results show the ablation will be larger than the accumulation as the Greenland ice sheet average, and the Greenland ice sheet will contribute to positive sea-level changes. However,the absolute values are spread, and the maximum value is lower than the estimation by Gregory and Huybrechts (2006).

Keywords: ice sheet, global warming

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1243**

Melting ice sheets, Earth's gravity field and global sea level

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William E. Featherstone, Oleg Makarynskyy, Wolfgang Keller

Currently, a huge amount of ice is locked away in the polar ice sheets over Antarctica and Greenland, which can increase global average sea level by about 64 m when its water equivalent is evenly distributed over the worlds oceans. Melting of considerable parts of these ice masses (especially over Greenland) seems possible in the near future (next few hundred to thousand years) based on current climate change studies. In this contribution, the impact of a complete melt of all land-based ice masses on global sea level, Earths gravity field and rotation vector are simulated. The simulations include the self-gravitational effect of the changing surface masses and are based on the topography, bathymetry and ice mass information given by the global 5-arc-min by 5-arc-min JGP95E digital elevation model. Furthermore, it uses an elastic (Gutenberg-Bullen) Earth model and assumed that the water equivalence of all ice masses is completely drained into the oceans. Results for a complete-melt scenario show that global sea level will not change in a uniform way, but will vary with location and ranges between -30 m (sea level fall) and +90 m. Furthermore, the Earths centre of mass will change by over 20 m and the Earths rotation expressed in length of day will slow down by about one third of a second.

Keywords: sea level, cryosphere

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1244**

Model Estimations of Present and Future Ice Conditions in the Arctic Basin

Dr. Alexander Makshtas
Air-sea interaction Arctic and Antarctic Research Institute IAPSO

Sergey Shutilin

The estimations of possible changes of sea ice conditions in the Arctic Basin up to 2060 is fulfilled with dynamic-thermodynamic sea ice model forced by projections of monthly average fields of surface air temperature and surface pressure, based on the results of five GCM (HadCM3, ECHAM5/MPI-OM, GFDL-CM2.1, CNRM-CM3, and INM) B2 scenarios. It is shown, that the maximal reduction of ice covered area and ice thickness in the Arctic Basin under different model forcing will not exceed 25 % up to 2060. Same time the detailed analysis of possible changes of sea ice cover till 2015 under forcing from practically all GCM shows increase in the area and thickness of sea ice cover in the European part of the Arctic Basin and small increase of ice thickness and reduction of ice area in the Pacific sector.

Keywords: ice, conditions, arctic

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1245**

Investigations of Sea Ice Conditions in the Arctic Using Lagrangian Tracking and Time History from Multisensor Data

Dr. John Heinrichs
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James Maslanik, Julienne Stroeve, Charles Fowler, David Long, Matthew Sturm, Thorsten Markus, Sheldon Drobot

Observations of a rapid decline in the extent of multiyear sea ice in the Arctic basin, and model predictions of future declines, have created an urgent need to understand the dynamic and thermodynamic processes that affect the Arctic sea ice cover. The evolution of multiyear sea ice in the Arctic basin has, however, historically been difficult to study because the ice is difficult to access and moves continuously. To address the need to understand the nature of ice transport and melt processes in the Arctic, the authors have applied a Lagrangian methodology in which individual parcels of ice are tracked and their characteristics observed using spaceborne remote sensing data. Sea ice drift tracks were obtained from buoys and passive microwave sensor data, specifically from the Special Sensor Microwave Imager (SSM/I) and the Advanced Microwave Scanning Radiometer (AMSR). Sea ice properties were derived from a variety of sources, including the SSM/I, AMSR, Advanced Very High Resolution Radiometer (AVHRR), the QuickSCAT scatterometer, and the RADARSAT-1 Synthetic Aperture Radar (SAR). Ambient meteorological conditions were obtained from the National Center For Environmental Prediction (NCEP) reanalysis fields. The drift trajectory tracking was used to demonstrate different time histories of albedo, skin temperature, and decrease in ice concentration as a function of location, drift track, and ice type, including examining contrasting conditions for ice parcels in 1993-1995 vs. 1996-1998, which represent two distinct periods of Arctic climatic conditions. The results suggest that surface temperatures over parcels that melt are much warmer in summer (as indicated by August), but also warmer in the preceding March and November of the previous year, and that there are substantial and identifiable differences in environmental conditions experienced by parcels that melt and those that survive over the entire year. In addition, a significant relationship was found between periods with a generally west-to-east (i.e., cyclonic) and south-to-north drift direction and reduced ice cover in the Beaufort, Chukchi and Siberian seas. The known relationships between atmospheric conditions, ice transport and ice extent and concentration suggest that this correlation is physical as well as statistical, although the relative importance of dynamical versus thermodynamical factors is uncertain. Another significant finding is that unlike earlier years, old ice is no longer surviving summer melt in the Beaufort and Chukchi seas, which means that atmospheric circulation patterns that would previously have acted to rebuild the extent of old ice by moving ice into the western Arctic instead are now causing additional loss of the oldest ice. Finally, forward modeling of SAR and passive microwave data indicate the importance of melt processes to understanding the seasonal evolution of backscatter and emissivity.

Keywords: sea ice, remote sensing, monitoring

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1246**

Real time monitoring of snowcover and snowmelt in the Himalaya

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Ramesh P. Singh

The Himalayan snow cover is found to be very variable in space and time. The characteristics of snow cover in the eastern and western part in the Himalayan region differ significantly from month to month and year to year. The strength and timely monsoon have some relation with the snow fall in the Himalayan region. For the flood monitoring, the snow cover monitoring is very important. In the present paper, we have carried out analysis of daily SSM/I satellite sensor data to study the snow cover variations for 10 years period 1995-2004. Daily and monthly maximum variation of snow cover has been analyzed. The rainfall data has been collected from Indian Meteorological Department (IMD). The April 2004 flood was a very rare event in the North Eastern region, possibly due to the combined effects of snow-melt and advancement of monsoon. Another important flood event was observed in October 2004, this was due to the stretching of monsoon. The early June flood might be attributed to combined effect of snowmelt and monsoonal downpour. The floods in late June, July, August and September are mostly governed by the rainfall which are common in the north eastern part. In the north western Himalaya , February month snow cover has direct influence on the rainfall in the month of July. It has been found that the 2002 excessive snow cover is the cause for the 2002 drought. The snow cover in the month of August found to show positive correlation with August month rainfall. The yearly maxima snow cover found to show a decreasing trend in the NE Himalaya, in contrast increasing trend is found in the NW Himalaya. The routine monitoring of snow cover and rainfall will be discussed in the prediction of flood and Monsoon.

Keywords: himalayan snow, monsoon, remotesensing

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1247**

Surface Climate Impacts on Greenland Ice Sheet Horizontal and Vertical Velocities

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Jason E Box

Greenland ice sheet changes in response to climate variability, both in vertical and horizontal direction, are investigated. ATM and ICESat measurements are used to compare with Polar MM5 modeled ice thickness change over Greenland ice sheet. The difference between observed thickness and modeled surface mass balance represents primarily glacier dynamics. Modeled temperature and PDD anomalies over Greenland major outlet glaciers are correlated with glacier velocities. Positive correlation between monthly temperature (PDD) anomalies and outlet glacier surface velocity suggest a significant sensitivity of glaciers to meltwater production. The horizontal and vertical velocity variations imply a linkage between short term surface climate variability and recent observed low-elevation thinning and outlet glacier acceleration on the Greenland ice sheet. This study validates the hypothesis that climate variability is at least partially responsible for glacier dynamical changes

Keywords: greenland, velocity, meltwater

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JMS016 **Oral Presentation** **1248**

Recent Observations of Greenland and Antarctic Mass Balance from ICESat and GRACE

Dr. Jay Zwally
other AGU

Waleed Abdalati, Anita Brenner, Matthew Beckley, Helen Cornejo, Mario Giovinetto, Jun Li, Scott Luthcke, Jack Saba, Donghui Yi

During the last two years, various estimates of the mass balance of the Greenland and Antarctic ice sheet have been published, including estimates of an accelerated mass loss from Greenland during approximately the last five years. However, some results differ by more than a factor of two, with some differences apparently due to errors in the methods as well as temporal variations in the mass balance. From 1992 to 2002, the Greenland mass balance was close to zero as shown by a combination of ERS 1 & 2 radar altimetry and airborne laser surveys. The Greenland ice sheet was thinning significantly below the equilibrium line and growing inland, both of which are expected responses to climate warming. During the 1990's, the West Antarctic ice sheet was losing mass significantly and the East Antarctic ice sheet was gaining a small amount. Recent data for 2003 to 2006 from ICESats laser-altimeter measurements of elevation change and GRACEs measurements of changes in gravity fields are providing information on temporal variations on the mass balance and are helping to resolve some of the methodological differences. From 2003 to 2006, inland growth on Greenland from increasing precipitation has increased, but the mass losses from enhanced thinning at lower elevations from increased melting and acceleration of some outlet glaciers has exceeded the inland mass gains. In Antarctica, the combination of ICESat and GRACE results, which are affected in different ways by glacial isostatic adjustment of the bedrock, are providing improved estimates of the mass loss from West Antarctica and the mass gain in East Antarctica. The northern part of the Antarctic Peninsula is losing mass, where some ice shelves have disintegrated, and the southern part is gaining mass. The principal temporal variations in Antarctica are in the coastal regions, which are more strongly affected by interannual variations in precipitation and ice accumulation.

Keywords: mass balance, ice sheet, icesat grace

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JMS016 **Oral Presentation** **1249**

Accelerated Chilean glacier contribution to sea-level rise

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Centro de Estudios Cientficos researcher IAHS

Francisca Bown, Gino Casassa, Cesar Acua, Fernando Ordenes

The great majority of Chilean glaciers have been retreating at high rates during recent decades, in response to widespread atmospheric warming above 850 hPa and decrease in precipitations observed in several surface stations. In Northern and Central Chile, the retreat of glaciers observed in the last century has been recognised as a regional trend, with a significant snowline elevation increase during the last quarter of the 20th century and the consequent rise in equilibrium line altitude of the glaciers, all of which is affecting future availability of water, as glaciers contribute up to 67% of the dry season runoff. In the Lake District, most of the glaciers have been retreating and shrinking in response to the regional climatic changes, although there are some fluctuations associated to the effusive and geothermal activity of ice-covered active volcanoes widely distributed in the region. In Patagonia, the research carried out in glaciers within larger icefields, such as the Northern and the Southern Patagonian icefields have revealed that recent volume changes have contributed to the global sea-level rise by 0.042 0.002 mm/year. This contribution to sea-level per area ratio is larger than that of Alaskan glaciers (Rignot et al., 2003), therefore factors others than climate should be as well affecting the glacier stability within this region. An updated glacier inventory is used here to account for the total amount of ice in Chile, including several areas never inventoried before. This new inventory is compared with previous data (Rivera et al., 2002) allowing estimations of glacier shrinkage which is showing an accelerated wasting trend in recent decades, especially in Patagonia. Digital Elevation Models are also used to estimate ice thinning, especially at low altitude of glaciers where old cartography is allowing topographic comparisons. More than 120 Chilean glaciers have been measured in terms of their recent frontal variations, and in some cases we have compiled long historical records of glacier fluctuations. The overall contribution of Chilean Andes glaciers to global sea-level rise is approximately 8 % of the total contributed by the mountain glaciers of the world, although in terms of surface area they represent only 3% of the glacier and icecap area. References Rignot, E., Rivera, A. & Casassa, G. (2003). "Contribution of the Patagonia Icefields of <st1:place w:st="on">South America</st1:place> to Global Sea Level Rise". Science,302: 434-437. Rivera, A., Acua, C., Casassa, G. & Bown, F. (2002): "Use of remote sensing and field data to estimate the contribution of Chilean glaciers to the sea level rise". Annals of Glaciology, 34: 367-372.

Keywords: glacier retreat, climate change, chile patagonia

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS016 **Oral Presentation** **1250**

Ice-sheet contributions to sea-level change

Dr. Robert Thomas
Self Centro de Estudios Cientificos

The rate of sea-level rise has increased from almost 2 mm/yr to more than 3 mm/yr over the last 20 years. Much of this increase was caused by very large increases in the transfer of ice on land to water in the ocean, both by increased melting and by increased glacier discharge into the sea. Most of this increase was from small glaciers outside of Greenland and Antarctica, but there have also been substantial increases in losses from the big polar ice sheets. This increase has been revealed primarily by the application of new remote-sensing techniques that provide different, independent ways to quantify the mass balance of the polar ice sheets. Here, I review results from this new information, and attempt to reconcile them in order to reconstruct a probable recent history of ice-sheet mass balance in both polar regions. This suggests that: (i) Higher-elevation parts of the Greenland Ice Sheet have thickened at accelerating rates, probably because of increasing snowfall. (ii) Despite this, total ice losses have increased substantially during the last 10 years, partly because of warming summer temperatures in Greenland, and partly because of increased outlet-glacier discharge in both polar regions. (iii) There is a strong correlation between increased glacier discharge and thinning or breakup of floating extensions of the glaciers. These conclusions highlight the sensitivity of the ice sheets to changes in both the atmosphere and the ocean. The ocean interaction is poorly understood, and could well be of most concern for the future.

Keywords: ice sheet, sea level

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JMS017 **1251 - 1260**

Symposium
The Holocene-Anthropocene Transition: From Natural to Human-Dominance of the Earth System

Convener : Prof. Michael Mann

Until recently, the Holocene climate of the last 10,000 years has been relatively stable, at least on a global basis. This period, also characterized by regional to global fluctuations of varying degrees, provides the context for human-induced change. Since about 1750, human activities have become a major factor in the climate, altering atmospheric composition and the land surface. With projections for the rates of change to continue, we are transitioning to a human-dominated climatethe Anthropocene has been coined to describe this emerging period. This symposium invites papers describing the Holocene climate (observational/ proxy or modeling); the forcings that humans are adding to the factors that have affected the climate in the past; documentation, detection, and attribution of the resulting changes; and projections of how these changes will develop in the future

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS017 **Oral Presentation** **1251**

Proxy-Based Reconstructions of Past Hemispheric and Global Mean Surface Temperature Variations

Prof. Michael Mann
climate ICCL IAMAS

Zhihua Zhang, Scott Rutherford, Raymond Bradley, Malcolm Hughes, Sonya Miller

We have produced a revised set of global and hemispheric mean surface temperature reconstructions for past centuries using a newly developed network of long-term climate proxy data. Three alternative statistical approaches that have been tested and validated in long-term climate model simulation experiments were used. The first approach is based on a scaling of composites of multiple proxy records, the 2nd approach is based on a regularized form of multivariate regression that takes into account proxy data uncertainties, and the 3rd approach employs a climate field reconstruction (

Keywords: paleoclimate, proxy, reconstructions

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS017 **Oral Presentation** **1252**

On the Anthropogenic Global Warming and Some it Consequences

Prof. Strachimir Cht. Mavrodiev
Theoretical and Environmental physics INRNE, BAS, Sofia IASPEI

The mathematical models of years Sun spots numbers, Sun heat budget and anthropogenic CO2 production are created. The models describe satisfactory the experimental data. The dependences of years CO2 atmosphere concentration, Earth mean temperature, Ocean mean level and World number of earthquakes with magnitude grater then 4 is analyzed and the corresponding mathematical models created: Model for anthropogenic CO2 production: CO2Anthro(Year), Model for Sun irradiation: SunIrrad(Year), Model for Sun Spots number: SunSpots(Year), Model for CO2 atmosphere concentration as a function of CO2Anthro, SunIrrad(Year) and SunSpots(Year): CO2Atm(Year), Model for Earth and some local stations year mean temperature as a function of CO2Atm(Year) and Earth ecosystem (Ocean- El Nino) response: TempEarth(Year), Model of Ocean level as function of Earth temperature, Model for magnitude spectral numbers as function of Earth temperature. From such model independent analysis and the functions presentation follow that the Earth temperature increase is straight consequence of CO2 anthropogenic production as well as the Ocean mean level and earthquakes number. A way for estimation of regional ecological CO2 responsibility using the atmospheric CO2 concentration time series (Mauna Loa, Schauinsland and Monte Cimone) and its fit functions (Mauna Loa, Schauinsland and Monte Cimone) is proposed. Such model can be used for better scientific based definition of the source contribution for CO2, other greenhouse gases and aerosols. A model for the local and Earth mean year temperature is presented on the basis of station and global CO2 data which allow predicting the next year temperature with an accuracy of about 0.5-0.7 degrees Celsius. Such technique has been tested with the data of Schauinsland, Hohenpeissenberg and Monte Cimone observatories and for the Earth as well. Shortly is discussed the creating of almost real time system for analyzing the experimental data, testing the accuracy of the different physical models solutions and reliability of their predictions. The including in the Stern report for estimation of Global Warming economical costs the seismicity part is proposed.

Keywords: vernadsky, antropogenic, changes

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JMS017 **Oral Presentation** **1253**

Holocene climatic-environmental variability in Campania and Apulia (southern Italy)

Dr. Amato Vincenzo
scienze della terra universit

High-resolution paleoclimatic studies (e.g. 18O, 13C, CH4, MS, ect) provide detailed reconstructions of the Holocene climatic variability. They give a good indications of the past temperatures and rainfalls, but they dont are unable to provide direct informations about the effects of the climatic changes on landscape and human ecosystems. In order to asses the response of the subaerial geomorphologic/pedo-sedimentary systems to the climatic changes and their potential impact on the ancient human communities, detailed stratigraphical investigations in southern Italy have been carried out. In addition to indications provided by litho-pedostratigraphical and geomorphological investigations, the study has recurred to historical, archaeological, and palaeobiological data. Such a multidisciplinary approach has allowed to better understand the significance of the changing events, enable us to distinguish the modifications induced by local/accidental agents (e.g. anthropogenic, physiographical) from those effectively due to potential global/semi-global climatic changes. The work shows the acquired geoarcheological, tephrastratigraphical and cultural data correlated to some selected high-resolution paleoclimatic records, from the Mediterranean areas (Allen et al., 2002; Allocca et al., 2000; Antonioli et al., 2000; Siani et al, 2004), and other boreal areas (Mayewski et al., 2004; Bond et al., 2001), showing a substantial variability of the Holocene climate leaded by a millennial cyclicity. Some of the main regional cyclical climatic changes, centred at c. 5.5-5.0; 4.0-3.7; 3.0-2.5; 1.5-1.0 ka BP, appear to coincide with significant changes of the morphodynamical processes recognised in the investigated successions. More precisely the climatic variability affected the subaerial environments principally by arresting or enhancing specific pedogenetic, erosional and/or sedimentary processes in different environmental contexts of the Campania and Apulia. This climatic-induced environmental modifications seem to have influenced human societies as well, affecting settlements, local occupation, circulation and the economic strategies. Many time the combined action of eruptions from the Neapolitan Volcanoes and climatic changes acted on the prehistoric and historic communities as factors able to destabilize the ecological balance, forcing interregional migrations of human groups which in turn could have caused social-economical crisis and even conflicts. References: Allen, J.R.M., Watts, W.A., McGee, E., et al. (2002) Holocene environmental variability the record from Lago Grando di Monticchio, Italy. Quaternary International 88, 69-80 Allocca, F., Amato, V.; Coppola, D., et al. (2000) Cyclical climatic-environmental variations during the Holocene in Campania and Apulia. Memorie Societ Geologica Italiana, 55, 345-352 Antonioli F. (2000) Le fluttuazioni del clima nellOlocene. Il Quaternario,13, 95-128 Bond, G., Kromer, B., Beer, J., et al. (2001) Persistant solar influence on North Atlantic climate during the Holocene. Science 294, 2130-2136 Mayewski, P.A., Rohling, E.E., Stager, J.C., et al. (2004) Holocene climate variability. Quaternary Research 62, 243-255. Siani, G., Sulpizio, R., Paterne, M., et al. (2004) Tephrostratigraphy study for the last 18.000 14C years deep sea sediment sequence for the South Adriatic. Quaternary Science Reviews 23, 2485-2500.

Keywords: geoarchaelogy, holocene, italy

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JMS017 **Oral Presentation** **1254**

Toward a better understanding of regional climate change in the Holocene

Dr. Drew Shindell
IAMAS

Climate models can be used to explore how the Earth responds to external forcings. In general these models yield results for historical global mean temperature similar to those from simpler energy balance models, and both suggest a dominant role in global mean temperature changes for volcanic forcing at short timescales and solar forcing at long timescales. Advances in paleoclimatology now allow use of the natural archive of climate records over the past millennium to evaluate how these external forcings affect large-scale regional climate patterns as well. The responses to these historical forcings can then be compared with simulations of the modern response to ozone depletion, greenhouse gas increases, and aerosol forcing. I will show that persistent solar irradiance increases lead to more ozone in both the stratosphere and in the uppermost troposphere, where it alters the tropospheric lapse rate and hence circulation. These changes enhance the response to solar-induced surface warming, resulting in precipitation increases along the equator and decreases in the subtropics. These appear to agree with the broad patterns inferred from paleoclimate data. This solar response is then compared with the response to modern greenhouse gas forcing. In the extratropics, the modeled responses to volcanism and persistent solar forcing both project strongly onto the North Atlantic Oscillation (NAO) or the Arctic Oscillation (AO, also called Northern Annular Mode). Similarly, the response to stratospheric ozone depletion projects strongly onto the Southern Annular Mode, while increasing greenhouse gases project onto both. Contrasts between the Northern and Southern Hemispheres suggest that much of the extratropical response to external forcing occurs via wave-driven processes. I will show that climate models including a relatively realistic representation of the stratosphere are able to reproduce many aspects of the dynamic responses inferred from observations/reconstructions. These results can thus provide valuable tests of models dynamic response to external forcing. Comparison with the response to 20th century greenhouse gas and aerosol forcing helps us to understand the causes of 20th century regional climate change, and to evaluate projections of future regional changes.

Keywords: solar, holocene, climate modeling

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JMS017 **Oral Presentation** **1255**

Simulations of the past millennium with the GCM ECHO-G: comparison with regional reconstructions and simulated surface energy balance

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Hans Von Storch, Fidel Gonzalez-Rouco, Sebastian Wagner

Results of several simulations with the climate model ECHO-G covering totally or partially the past millennium will be shown. In all of them the model was driven by the same external forcing, with an amplitude of past solar variations that correspond to a change of 3 per mill between the Late Maunder Minimum and present. The simulated regional trends agree well with recent regional reconstructions (Alpine summer temperature) and long early instrumental data (Central England Temperature record). For other long series, e.g. Scandinavian temperature, there exist a clear disagreement. The simulated radiation balance at the surface shows some intriguing aspects. The solar radiation reaching the surface is actually slightly larger in the past centuriues than today, due to the response of cloud cover to lower global temperatures. In a continuation of the simulations until 2100 A.D under SRES scenarios, the reversed feedback is also observed. The simulations also allow for an assessement of the role of the internal variability versus external forcing for the variations in the modes of atmospheric circulation. In these simulations, this response can be indetified at very long (centennial) timescales, inspite of the fact that the ECHO-G model shows a very strong response of the NAO in the scenario runs. At decadal and multidecadal timescales, the NAO variability seems to be almost purely internal. The simulated heat flux into the ocean attaines ints largest values at the end of the 20th century, about 0.8 watt/m2, agreeing with recent estimates of imbalances of the Earth radiation budget.

Keywords: past millennium, echo g, enery balance

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JMS017 **Oral Presentation** **1256**

Mid-Holocene climate shift induced by increasing carbon dioxide and surface albedo changes is correlated with global cultural hiatuses

Prof. Andrew Bush
Earth and Atmospheric Sciences University of Alberta IAMAS

Apparent from proxy data collected from both hemispheres, particular regions experienced colder and wetter conditions in the early Holocene (prior to 7,000 years before present (7ka BP)) and warmer and drier conditions after 6ka BP, with a relatively rapid transition between 6ka and 7ka. Some of the proxy data come from archeological sites and their surrounding areas. Archeological sites from both hemispheres (Asia and Brazil) demonstrate cultural hiatuses (i.e., cultural replacement) that are coincident with this climate change. Global numerical simulations spanning the Holocene are presented here and do show the 7k-6k transition that is quite rapid in regions such as central Asia. This climate shift correlates well with a variety of proxy data taken from and around Lake Baikal in Russia and Lake Hovsgol in Mongolia. The simulated mid-Holocene climate shift is attributed to the gradually increasing values of atmospheric carbon dioxide as well as to changes in the land surface albedo associated both with the elimination of the remnants of the Laurentide Ice Sheet and with concomitant changes in snow cover. These two mechanisms combined produce a more rapid transition than would have occurred from the changes in carbon dioxide alone. While one cannot infer cause and effect from a correlation, these results nevertheless suggest that the mid-Holocene climate shift is likely to have played a significant role in the cultural hiatuses recorded in both hemispheres and may aid in interpreting the role of climate in human history.

Keywords: holocene, culture, climate

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JMS017 **Oral Presentation** **1257**

From a climate to man-controlled C budget in a temperate wetland (Las Tablas de Daimiel National Park, Central Spain)

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Rosa Mediavilla, Fernando Dominguez-Castro, M Jose Gil-Garcia, M Blanca Ruiz-Zapata, Cristino J. Dabrio

Las Tablas de Daimiel National Park is a fluvial wetland, located in the Mediterranean area (central Spain), characterized by a noticeable bioaccumulation of C (both organic and inorganic) since more than 3000 years ago. Man is present in the area since Late Pleistocene times, but without a noticeable impact on the system. So, for most of the record, the bioaccumulation of C was controlled by climate as rainfall and temperature ruled the water table level and, therefore, the available space for sediment accumulation and the relation between the aquatic and the paludal vegetation. But, for the last millennium, man-induced changes on land use and on the vegetal cover have increased substantially and, for this period, it is possible to follow the transition from a natural (climate) dominated system to a pure anthropogenic system and the changes induced in the C budget of the area. For the climate-controlled period (up to the second half of the 19th century AD), short aridity pulses are recorded as a decrease in the accumulation of inorganic C, as the water table shallows and retreats, while organic C increases, as result of the expansion of the paludal fringe. But, for decadal to centennial scale, increased aridity is recorded as an increase in the background of inorganic C while organic C upper limit drops as consequence of higher tolerance to salinity changes of the aquatic taxa. During this period, man action is restricted to occasional changes in the grazing lands or punctual fires that do not affect noticeably the C budget. However, spreading of farming against livestock (late 19th century) and introduction of machinery and irrigation (second half of the 20th century) caused the rupture of the hydrological cycle and, consequently, the previous relations between the elements of the C-cycle were broken. Accordingly to these arguments, we identify three periods for the last millennium: 10th-13th century AD: warm and wet stable conditions. It is the period with less total-C stored per unit area but, probably, the accumulation area was the greatest. 14th-late 19th century AD: very fluctuating climate, alternation of droughts and floods but with a trend to aridity, chiller temperatures and cooling trend. Instantaneous C values reach their maxima but a decreasing trend is recorded during this period as result of the degradation of the emergent vegetation. In addition, the flooded area reduced. Late 19th-present: man action is too intense to derive a relation between climate and environmental changes. Changes in C storage are related to man-induced fluctuations of the water table and alterations of the vegetal cover. The flooded area almost disappears. Acknowledgements This research is supported by the Spanish Ministry of Science and Education (MEC) projects REN2002-04433-CO2 and CGL2005-06458-CO2-01/HID.

Keywords: c cycle, last millennium, terrestrial

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS017 **Oral Presentation** **1258**

Relevance of the mid- to late-Holocene Period for Assessing Anthropogenic Climate Change

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Information about climate of the mid- to late-Holocene offers our best chance to study relevant climate variability and change for society. We know that a substantial part of the large scale climate variability is driven by external forcing factors, but there are also important internal fluctuations that affect climate at more regional scales. Identifying and understanding change that can be associated with forcings and separating those from unpredictable variability is a process that forms the foundation of any skillful projection of future anthropogenic climate change. As we go back in time, the accuracy and precision of climate as well as forcing information deteriorates. How does this affect our ability to detect past changes and to attribute them to the respective forcings? Climate models offer a useful test environment for such questions and allow for an assessment of how well our understanding of past and present regional climate variations can serve for an interpretation of current and future change as it emerges seamlessly from the natural background.

Keywords: holocene, climate change, forcing

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JMS017 **Poster presentation** **1259**

Bayesian multi-scale smoothing as a new tool for reconstructing regional climate and separating natural climate variability from human induced changes

Dr. Sanna Sorvari
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Atte Korhola, Lasse Holmstrm, Jan Weckstrm, Panu Erst

Empirical calibration of training sets using air temperatures from distinct locations has hitherto been regarded as satisfactory for accurate climate reconstructions, but different proxies have yielded different reconstructions from the same sediment record. It is therefore difficult to make any generalizations on the basis of such data. Here we reconstruct Holocene temperatures for Finnish Lapland by utilizing simultaneously data from multiple biological proxies (pollen, chironomids, diatoms) of two lakes, using new method of Bayesian multi-scale smoothing to achieve a regional consensus reconstruction of temperature. This technique also allows significant features to be detected from the emerging time series. At millennium scales, the temperatures exhibit a statistically significant early Holocene warming trend, followed by the general cooling period prior to industrialization. On centennial scales, repeated warm episodes, not abrupt coolings, seem to have been the major feature of Holocene climate. Rising temperatures were characteristic for 11000 8500, 7600 7500, 6500 6300, 4700 4500, 2800, and 1800 1700 cal yr BP; the recent global warming is also evident in our record. Contrary to the conventional view, our results indicate that the climate since late-Holocene climate cooling in Lapland started already 8500 cal yr BP and that climate since then was punctuated by several quasicyclical warming events, the forcing mechanisms of which are not yet fully understood.

Keywords: holocene, climate, multi scaling

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JMS017 **Poster presentation** **1260**

Reconstruction and analysis of past climate of the Carpathian Basin in 500-1900 AD

Dr. Rita Pongracz
Dept. of Meteorology assistant professor IAMAS

Judit Bartholy

In order to cover several centuries of the past climate, various proxy data series play an essential role since regular meteorological observations being reliable started only in the 1800s. Among many others, the proxy climate sources include the historical documentary data. Written documentary sources can be used to evaluate the occurrence, duration and geographical location of climatic events of the past centuries when no or only scarce instrumental time series are available. For the Carpathian basin (located in Central/Eastern Europe), Antal Rthly (a Hungarian climatologist of the 20th century) collected historical documents in their original form containing meteorology-related information into the 2500-page-long book series, titled "Meteorological events and natural disasters in the Carpathian basin". In order to facilitate the detailed analysis of this documentary collection, a special code system using hierarchical subclasses has been defined. The applied code system distinguishes three main categories of climate information: temperature, precipitation and wind related events, containing about 3800, 10000, and 1300 information items, respectively. Furthermore, the three level subclass system involves 10 second-level classes and 61 third-level classes. In case of temperature related documents, reports on cold conditions dominate (65%), while in case of wind related events, most of the archive records mention the strength. Precipitation information takes 66% of the total collection and the most often reported event is the rain, which can be explained by the source types (many estate records and account rolls) and by the agricultural importance of water. Other frequent classes of precipitation are thunderstorm, hail, flood, and drought. Besides the event classification, the coded database contains full geographical information about the location of the meteorological events (e.g., settlement, geographical coordinates, and subregion identification). Spatial and temporal distribution of precipitation, temperature, and wind related climate events and extremes have been investigated using both settlement and subregional scales. Geographical distribution of extreme climate events has been mapped. Decadal, annual, and seasonal time series have been analysed for the Carpathian Basin, and compared to other reconstructed temperature and precipitation index time series from other geographical locations in Central/Eastern Europe.

Keywords: documentary data, carpathian basin, rethly

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JMS018 **1261 - 1289**

Symposium
High Latitude Modes of Climate Variability

Convener : Dr. David Bromwich

The climates of the Arctic and Antarctic are governed by the large scale modes of atmospheric variability such as the Northern and Southern Annular Modes (NAM/SAM), and the El Nio-Southern Oscillation that is manifested in high latitudes by the Pacific-North American and Pacific-South American (PNA/PSA) patterns. The impacts of the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation will also be explored. The symposium will be concerned how these patterns are changing and affecting high latitude climate, how the different modes interact and the mechanisms by which this occurs, the roles of high latitude versus tropical forcing, the roles of the ocean and sea ice cover in initiating and/or amplifying change, stratospheric versus tropospheric causes of variability, and the issue of natural versus anthropogenic forcing. Contributions are solicited from all approaches that bear on these topics, such as observational analyses from reanalyses and ice-core records, theoretical studies, and all types of numerical modeling

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1261**

Stratosphere-Troposphere coupling and links with Eurasian Land-Surface variability

Dr. Judah Cohen
Atmospheric and Environmental Research, Inc.

Mathew Barlow, Paul J. Kushner, Kazuyuki Saito

A diagnostic of Northern-Hemisphere winter extratropical stratosphere-troposphere interactions is presented to facilitate the study of stratosphere-troposphere coupling and to examine what might influence these interactions. The diagnostic is a multivariate EOF combining lower-stratospheric planetary wave activity flux in December with sea-level pressure in January. This EOF analysis captures a strong linkage between the vertical component of lower stratospheric wave activity over Eurasia and subsequent development of hemispheric-wide surface circulation anomalies, which are strongly related to the Arctic Oscillation or the Annular mode. Wintertime stratosphere-troposphere events picked out by this diagnostic often have a precursor in autumn: years with large October snow extent over Eurasia feature strong wintertime upward-propagating planetary wave pulses, a weaker wintertime polar vortex, and high geopotential heights in the wintertime polar troposphere. This provides further evidence for predictability of wintertime circulation based on autumnal snow extent over Eurasia.

Keywords: annular mode, predictability, stratosphere

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JMS018 **Oral Presentation** **1262**

Atmospheric mechanisms related to extreme intraseasonal temperature anomalies in the Antarctic Peninsula during the winter season

Mrs. Nathalie Boiaski
Atmospheric Sciences University of Sao Paulo IAMAS

Leila Maria Vespoli De Carvalho

Observations suggest that the stratospheric circulation plays a key role in modulating polar temperatures. We investigate dynamical process related to extreme intraseasonal (20-100 days) air temperature anomalies in the Antarctic Peninsula region during the winter season and show evidence of a troposphere-stratosphere interaction on intraseasonal time-scale. During cold extreme events, persistent cyclonic anomalies are observed over Antarctic Peninsula along with the enhancement of wave activity in the extratropical SH lower stratosphere and weakening of the polar jet. Opposite situation was verified during the warm extreme events. Anomalies persist approximately 10 days for both the extremes (cold and warm); suggesting an intense exchange of energy between troposphere-stratosphere in association with intraseasonal events due to Rossby wave propagation.

Keywords: antarctic peninsula, intraseasonal activity, extreme temperature

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1263**

Interactions between the Southern Annular Mode and the Mean State

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We study the influence of the background state on the structure and dynamics of the southern hemisphere annular mode (SAM), defined as the first EOF of monthly 850hPa geopotential anomalies. To that end, subsets of the climatology are constructed for different seasons and for contrasting polarities of the ENSO cycle. The analysis is based both on observations and on perpetual-state GCM experiments. During the austral summer, the climatology is characterized by a single, well-defined, eddy-driven jet centered at a varying mean latitude between subsets. In all the cases, the SAM is to first order a latitudinal shift of the jet about its mean position, reinforced by a positive momentum flux feedback from baroclinic waves. These results, consistent with previous studies of the zonally-averaged dynamics, are found here to hold over all longitudes and for different positions of the mean jet. The strong differences in the amplitude of the SAM among the various climatologies seem to be determined by a combination of (1) the variance of the "random" forcing by transient eddies, and (2) the strength of the positive feedback component of this forcing. The latter mechanism tends to become stronger when the mean jet moves equatorwards. During the austral winter, a strong subtropical jet lies over the Indo-Pacific sector in addition to the eddy-driven jet. The SAM structure in geopotential and zonal wind anomalies remains quasi-zonally-symmetric, but it exhibits two different relationships with the climatological features at different longitudes: (1) over the sector in which the subtropical jet is weak, the SAM represents a shift of the midlatitude jet about its mean position, as in summer. (2) It becomes instead a see-saw between the midlatitude and subtropical jet over the longitudes where the latter is strong. Correlation analysis and composites show that this result is not a statistical artefact of the EOF technique

Keywords: southern annular mode, jet eddies interaction, variability

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JMS018 **Oral Presentation** **1264**

Relationship between Arctic climate modes and daily weather patterns in the Mackenzie and Yukon watersheds

Dr. John Cassano
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Elizabeth Cassano

The method of self-organizing maps (SOMs) was used to create an objective synoptic climatology of daily sea-level pressure (SLP) patterns over the Yukon and Mackenzie watersheds. This synoptic climatology was based on ERA40 data and identified a total of 35 unique SLP patterns for this region. The frequency of occurrence of these patterns on seasonal, annual, and interannual time scales has been determined. Relationships between the frequency of occurrence of the different daily SLP patterns and the major modes of Arctic climate variability (Arctic Oscillation and Pacific Decadal Oscillation) have also been determined. Finally, changes in the frequency of occurrence of these weather patterns over time (from 1958-present) has been evaluated. These results provide a method for relating daily weather patterns to the larger climate of this region, and provides a physically consistent link between weather and climate.

Keywords: polar, climate, synoptic

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JMS018 **Oral Presentation** **1265**

Tropical intraseasonal activity and impacts on the lower-stratosphere and antarctic ozone during the austral spring.

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Charles Jones, Tercio Ambrizzi

Observations suggest that the rate of decrease of stratospheric ozone over Antarctica has slowed since the 1990s with large interannual variability. Here we investigate the relationships between tropical intraseasonal activity in the circulation of the upper troposphere and the dynamics of the stratospheric polar jet during the austral spring. We show that there is strong correlation between variations in the kinetic energy on intraseasonal time-scales at 200hPa over the tropics and subtropics (0-40 S) and in the lower stratosphere at high latitudes (50-80S) of the Southern Hemisphere. Using lag-composites of the Eliassen-Palm flux anomaly vectors, zonal intraseasonal circulation at 200hPa and 50hPa we show evidence that intraseasonal anomalies in the upper-troposphere tropical circulation leads intraseasonal anomalies in the lower-stratosphere at high latitudes by 1-2 pentads during the austral spring, with impacts in the total Antarctic ozone. It is shown that differences in the total Antarctic ozone 1-2 pentads after easterly (westerly) intraseasonal anomalies are observed at the equatorial western South America are as large (as low) as 25 DU (-25 DU) during the austral spring. The variability of intraseasonal activity in the lower stratosphere at high-latitudes has increased in the last decade, as well as the trends in the intraseasonal activity south of the Equator from 120-110W during austral spring. The association between tropical and polar lower stratosphere intraseasonal activity occurs via upward Rossby wave activity. Changes in tropical intraseasonal activity agree with the rate of decrease of Antarctic ozone since 1979, and are consistent with trends in the 1990s relative to early records.

Keywords: antarctic ozone, intraseasonal, lower stratosphere

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JMS018 **Oral Presentation** **1266**

Meridional and Vertical Out-of-Phase Relationships of Temperature Anomalies Associated with the NAM variability

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Ming Cai

Using the NCAR/NCEP reanalysis, we in this study present some evidence suggesting that the out-of-phase relation of temperature anomalies between the low and high latitudes and between the stratosphere and troposphere is intimately related to the meridional and downward propagation of anomalies of both signs. The temperature anomalies above the tropopause propagate poleward whereas the temperature anomalies below propagate equatorward covering the entire hemisphere with a characteristic time scale of about 55 days between the equator and the pole. The well-known out-of-phase oscillatory pattern between low and high latitudes found in monthly data could be attributed to the relatively slow meridional propagation. The equatorward propagation in the troposphere is synchronized with the poleward propagation of the stratospheric temperature anomalies of the opposite sign in both low and high latitudes. The synchronized stratospheric poleward and tropospheric equatorward propagation spanning over the entire hemisphere not only helps to explain the out-of-phase relation between the stratospheric and tropospheric temperature anomalies in the polar region, but also relates the tropospheric temperature anomalies in the extratropics to upper level temperature anomalies in the tropics. Since it takes about 55 days for anomalies of one polarity to propagate from the tropics to the pole, such an intimate linkage between the anomalies in the deep tropics and high latitudes would naturally imply a longer lead time for intra-seasonal climate prediction in the extratropics.

Keywords: temperature anomalies, out of phase relationship, nam

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JMS018 **Oral Presentation** **1267**

Teleconnections and the Arctic Oscillation observed in the barotropic component of the atmosphere

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Ippo Suzuki

In this study, teleconnectivity and one point correlations are analyzed for the barotropic component of the atmosphere represented by a simple barotropic model (called barotropic S-model), and the results are compared with observation by the NCEP/NCAR reanalysis. It is confirmed that the teleconnectivity and the PNA pattern are perfectly simulated by the barotropic S-model. The question is focused whether the Arctic Oscillation appears by the one point correlation. According to the result, it is found that the one point correlation is not restricted within the Atlantic sector like the NAO, but spread to entire mid-latitudes surrounding the Arctic. The positive correlations in the Pacific sector are all statistically significant at the 5% confidence level. The result suggests that the AO is not a statistical artifact due to the multiple teleconnections of the NAO and PNA, but a physical mode with dynamical basis. The reduced correlation in the observation may be the influence of the transient noise.

Keywords: arctic oscillation, northern annular mode, teleconnection

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JMS018 **Oral Presentation** **1268**

Sensitivity model study of Arctic ice-ocean interactions during the Little Ice using different radiative and wind stress forcings

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In the past, the main drivers of the Little Ice Age (LIA) have been identified as volcanic eruptions, insolation changes and greenhouse gas changes. Furthermore, changes in the global ocean circulation have been detected from proxy data. One component which links the atmosphere and the ocean circulation is the sea ice. This study investigates the role Arctic sea ice has played in shaping the LIA climate using a global intermediate complexity model with an EMBM for the atmosphere, a GCM for the ocean, and a dynamic-thermodynamic model for the sea ice. In order to carry out this study, different wind stress fields for the LIA period are used for the model. In addition to a climatological wind stress field and one obtained from an AGCM run for the LIA, three other wind stress fields have been developed using NAO reconstructions for the LIA. The results of a sensitivity study are presented using these different wind stress and radiative forcings, and in particular, the changes to the sea-ice cover and ocean circulation are examined. Specifically, we find that the ice area and volume show a clear volcanic signal.

Keywords: little ice age, sea ice, model

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1269**

Oceanic and atmospheric transport of multi-year ENSO signature to the Polar Regions

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We present the clear observational evidence with high statistical significance of the dynamic linkages, and putative mechanisms, especially for the low frequency components (13.9- year signal), between the ENSO, AO and the Northern Hemisphere ice conditions over the past 150 years. Using the advance statistical methods we separate statistically significant components from time series and demonstrate that the times of largest variance in ice conditions are in excellent agreement with significant power in the Arctic Oscillation (AO) and Southern Oscillation Index (SOI) at 2.2-3.5, 5.7 and 13.9 year periods. The 2.2-3.5, 5.7 year signals are generated about three months earlier in the tropical Pacific Ocean. In contrast the 13.9 year signal propagates from the western Pacific as eastward propagating equatorial coupled ocean waves, and then fast boundary waves along the western margins of the Americas to reach both polar regions, and has a phase difference of about 1.8-2.1 years by the time it reaches the Arctic.

Keywords: ao, enso, soi

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1270**

The Growth and Triggering Mechanisms of PNA : A MJO-PNA coherence

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A prominent mode of low-frequency variability in the northern extratropical winter is the Pacific/North American (PNA) teleconnection pattern which represents variability not only on seasonal but also on intraseasonal time scales. In this study, processes governing the intraseasonal PNA are investigated using daily fields during 1957-2002. The results of the vorticity budget analysis reveal that the growth of PNA is generally dominated by linear processes, such as the barotropic energy conversion from the zonally asymmetric climatological flow. A nonlinear forcing associated with high-frequency eddies is not prevailing, but does contribute to the PNA growth and maintenance. Composite life cycle of the PNA shows that 9 days before the negative peak of the PNA events a pronounced wave train was observed along the Asian jet stream and it eventually develops to the PNA near the jet exit region. This wave train is found to be intermittently excited by the anomalous convection associated with the Madden-Julian Oscillation (MJO). When the MJO is active (inactive) over the Bay of Bengal to the western Pacific, it triggers the wave train which grows the negative (positive) PNA. This MJO triggering explains roughly 30% of the total PNA events, suggesting that, even though the PNA may be inherent to the extratropical atmosphere, a specific external forcing is of importance to realize the PNA as dominant mode.

Keywords: pna, mjo, teleconnection

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1271**

Links between the mountain torque and the Arctic Oscillation

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The fact that the evolution of the Arctic Oscillation is in part affected by mountains is shown using various pieces of independent evidences. First, in the NCEP/NCAR reanalysis we show that, at periodicities around 30 days and below, the mountain torque (Tm) drives most of the changes in the Atmospheric Angular Momentum (AAM). At these periodicities, the variations in AAM are equally distributed between variations in wind AAM (Mw) and mass AAM (Mm). This equipartition is explained theoretically as the result of the geostrophic adjustment of a barotropic axisymmetric flow to the mountain torque. As the Arctic Oscillation (AO) is associated with a redistribution of the atmospheric masses from the polar regions to the midlatitudes, it is associated with substantial mass AAM. Accordingly, we also found that in the NCEP data, the AO variations are very significantly related to mass AAM variations driven by Tm.Second, these results are confirmed by using a 30-year simulation done with the Laboratoire de Mtorologie Dynamique (LMDz), general circulation model. In this respect, the LMDz model has the great advantage of closing the AAM budget nearly exactly, which is not the case with the NCEP reanalysis data. In this model, we verify that the torque Tm and the AO are in lead-lag quadrature, the relationship between the two being associated with the variations in mass AAM driven by the montain torque.Finally, as the Antarctic Oscillation (AAO) is also associated with a redistribution of mass from the polar regions to the midlatitudes, its contribution to the AAM budget is also presented. As there are much fewer mountains in the Southern Hemisphere, we show that in the model as well as in the reanalysis the changes in mass AAM duringintraseasonal variations of the AAO are in good part equilibrated by changes of opposite sign in wind AAM.The main interest of these results is that the mountain torque drives the changes in AAM, so it can sometimes participate actively in changes of the AO. It has a predictive value that is significant but small, around 10-15% for periodicities near and below one month, while a good fraction of the AO variability occurs at longer timescales.

Keywords: arctic oscillation, mountain torque, atmospheric angular momentum

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JMS018 **Oral Presentation** **1272**

3D Eliassen-Palm fluxes in stratosphere and troposphere

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Using the monthly mean NCEP/NCAR reanalysis data for winter period (December - March) from 1948 to 2006, the three - dimensional Eliassen-Palm (E-P) fluxes and their empirical orthogonal functions were calculated at standard levels in the troposphere and stratosphere in order to investigate the propagation of planetary waves. During anomalous warm or cold winters in the Arctic stratosphere we observed different wave propagation in the troposphere. It was shown that in the case of stratospheric sudden warmings direction of the vertical component of E-P flux is upward over Chukotka and downward over Alaska. Planetary waves are focused in this area before stratospheric sudden warmings events. Interannual variations of the vertical E-P component in December is in a good accordance with the stratospheric warming occurrence in January. A possible mechanism of relations between the stratosphere - troposphere coupling and sea surface temperature (SST) anomalies in extra-tropical Pacific and Atlantic is presented.

Keywords: sudden stratospheric warming, stratosphere troposphere, eliassen palm flux

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JMS018 **Oral Presentation** **1273**

Regional circulation changes in the Antarctic Peninsula from ice core records

Dr. Liz Thomas
IAMAS

Gareth Marshall

We present preliminary results from a new shallow (130 metres) ice core drilled in a relatively high accumulation site (Gomez) on the southwestern Antarctic Peninsula during the 2007 season. The Antarctic Peninsula region has experienced dramatic changes in climate over the past 50-years of observational record: annual temperatures have increased greater than elsewhere in the Southern Hemisphere and many ice shelves fringing the Peninsula have disintegrated. Contemporaneously, changes in the regional atmospheric circulation have also been observed: in particular the Southern Hemisphere annular mode (SAM), an index of the circumpolar westerlies, has become more positive in summer and autumn. The aim of the new core is to extend our understanding of atmospheric circulation in this region beyond the period of observational record and thus to set the recent climate change in a longer temporal framework. Analysis of accumulation data in the European Centre for Medium-Range Weather Forecasts re-analysis (ERA-40) demonstrates a significant positive statistical relationship between the SAM and accumulation in the southern Peninsula region. Thus as the initial step in analysing the Gomez core we compare annual accumulation, against a SAM index. Additional ice core records from the Peninsula will also be presented to help constrain the spatial extent over which any significant SAM-accumulation relationships exist.

Keywords: southern annular mode, ice cores

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JMS018 **Oral Presentation** **1274**

The role of the annular modes in recent trends in sea ice

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The Arctic and Antarctic have experienced remarkably different trends in sea ice extent in recent decades. Over 1979-2004 Arctic sea ice extent decreased by 38,000 sq km per yr or 3.2% per decade, with the greatest trend during the autumn and summer and a loss of 7.5% per decade in September. In contrast, Antarctic has experienced a small but significant increase of annual mean sea ice extent of 1.2% per decade over the period 1979-2005. The increase is greatest (5.6% per decade) near the sea ice extent minimum in March and is smallest (0.4% per decade) in August close to the sea ice maximum. The trends in Antarctic sea ice extent vary considerable around the continent, with the greatest increase being in the Ross Sea (+4.8% per decade) and the largest loss being in the Bellingshausen Sea (-5.3% per decade). Around the rest of the continent the annual mean extent has increased by about +1% per decade. In the Arctic, the Northern Hemisphere Annular Mode has its greatest influence during the winter months and the sea ice trends are primarily attributed to the ice-albedo feedback. In the Antarctic, the largest increase in sea ice coincides with the greatest shift of the Southern Hemisphere Annular Mode into its positive phase. The regional variations in the sea ice trend will be explored in relation to the SAM and changes in the long wave pattern around the continent.

Keywords: sea, ice, trends

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JMS018 **Oral Presentation** **1275**

Distinguishing trends from multi-decadal variability in the Antarctica circulation: A view from the South Pole with recent climate model insights

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Judith Perwitz, Martin Hoerling

The interpretation of trends and variability in the Antarctic circulation is limited by the relatively short rawinsonde record over Antarctica from 1957 to the present. A number of recent papers have sought to detect climate change over Antarctica using both sounding data and surface observations from the continent (Marshall, 2002; Marshall, 2003; Thompson and Solomon, 2002; Turner et al., 2006) . Additional insight has come from both station analyses and paleoclimate records (Jones and Widmann, 2003; Jones and Widmann, 2004) . Two additional papers are currently in preparation addressing 1) analysis of trends from upper air sounding sites located on the continent with a special emphasis on sounding data from the South Pole, the only remaining sounding site in the interior of Antarctic still in operation since the IGY in 1957 (Neff, Perwitz, and Hoerling: to be submitted to GRL) and 2) a climate model analysis of tropical ocean forcing of southern hemisphere polar climate change that focuses, in particular on the south polar response to warming of the Indian Ocean over the last several decades (Perwitz, Li, Hoerling, and Neff: to be submitted to GRL). In this presentation we will review these recent results and their implications for the interpretation of long-term trends and the confounding influences of multi-decadal variability.

Keywords: antarctica, climate, trends

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JMS018 **Oral Presentation** **1276**

Trends in the daily extreme temperatures in the Antarctic Peninsula

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Jorge Carrasco, Patricio Aceituno

Changes and trends in the daily extreme temperatures in the western side of Antarctic Peninsula and the composite synoptic-scale pattern associated with them are studied for the 1971-2000 period. Climatological indices were selected from the list of the climate change indices recommended by the Research Programme on Climate Variability and Predictability (CLIVAR) and the synoptic pattern were constructed using the ERA-40 database. Thus, cold and warm nights were respectively defined as all those minimum temperatures falling below the10% or above 90% of the accumulative distribution function. As preliminary results, a decrease in the percentage of cold nights was found in the region being statistically significant at the level of 90% at Faraday/Vernadsky and Frei station, which is associated with positive anomalies in sea-level pressure (SLP) over Bellingshausen Sea. On the other hand, a positive trend of warm nights in summer (December-January-February) and autumn (March-May) was observed being significant at Frei station and it is associated with negative anomalies on SLP over Bellingshausen Sea. The observed warm over the Peninsula Antarctica is mostly due to fewer cold nights, this implies a decrease of the extreme cold nights, in other words, a warming on the cold tail in the daily extreme temperature accumulative distribution. The synoptic-scale analysis indicates that the negative (positive) trend of cold (warm) nights is associated with a decrease (increase) of southern (northern) airflow, i.e., decrease of cold (warm) advection over the western side of the Peninsula Antarctica.

Keywords: era40, cold nights, warm nights

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1277**

Independent Components in the Northern Hemisphere Winter: Is the Arctic Oscillation an independent mode?

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We examine what are true oscillations in the Northern Hemisphere winter,by using independent component analysis (ICA). ICA can distinguishbetween true and apparent oscillations, when it is assumed that trueoscillations are mutually independent. The basic idea of thediscrimination is that independent and dependent oscillations havedifferent probability density functions (PDFs); PDFs of independent(dependent) oscillations are far from (close to) the normal dstribution.Special attention is paid to the Arctic Oscillation (AO). First, ICA is made on the NCEP-NCAR reanalysis data. Independentcomponents are found for the sea level pressure (SLP) and 500 hPa height(Z500) fields. Their patterns of the SLP can be identified as the NorthAtlantic Oscillation (NAO) and the Pacific-North American (PNA)patterns, although the latter exhibits a seesaw pattern between theAleutian and Icelandic lows. Thus, the AO is an apparent mode derivedfrom them. However, since the period of the data is too short,statistical significance cannot be obtained.Then, ICA is performed on the present climate experiment data of theMeteorological Research Institute. Also in this data, it can be judgedthat the NAO and the PNA-like patterns are independent for both of theSLP and Z500, where the PNA-like pattern is somewhat different from theobserved PNA pattern. Again, it can be concluded that the AO is notindependent, but this time with statistical significance.

Keywords: independent component, arctic oscillation, north atlantic oscillation

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JMS018 **Oral Presentation** **1278**

High latitude modes and trends in the IPCC AR4 models

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We assess the representation of high latitude modes and climate trends in the IPCC AR4 model simulations of the late 20th century, and examine the "local" modes of atmospheric and sea ice variability, as well as those related to tropical teleconnections. We attempt an objective assessment based on the calculation of "skill scores" comparing model and observed modes, finding a wide variation in skill between various models. More particularly, we consider temperature trends over the continent over the last 40 years. Individual models show a very wide scatter in their simulated temperature trends over this period. The large trend over the Antarctic peninsula in winter is not well represented, which makes it clear that whatever has been driving these trends is not well captured by many GCMs. Only a few individual models produce creditable simulations of what has been observed. Trends in temperature are clearly linked to the sea ice simulation, another variable that most models do not simulate well.

Keywords: ar4, skill score

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JMS018 **Oral Presentation** **1279**

Changes in snowfall and near-surface temperature over Antarctica during the past 50 years in IPCC AR4 GCMs

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David H. Bromwich, David P. Schneider

There are a handful of continuous snowfall and near-surface air temperature records spanning more than a decade in Antarctica, a continent that is 1-1/2 times the size of the United States. Southern high-latitude modes of climate variability are known to occur on multi-decadal timescales. Thus to place Antarctic climate variability in the context of the longer-term changes observed across the globe, understanding large-scale Antarctic snowfall and near-surface air temperature variability for an extended period is desirable. Here, we employ the spatial and temporal continuity of simulated snowfall and 2 m air temperature fields from an atmospheric model as background fields to create ~50-year gridded Antarctic snowfall and near-surface air temperature records from observations. We examine the relationship between temperature and snowfall, and compare the results to global climate model (GCM) simulations associated with the Intergovernmental Panel on Climate Change Fourth Assessment Report. The GCMs are able to reproduce the observed sensitivity of Antarctic snowfall to near-surface temperature, but simulations of near-surface temperature trends during the 20th century are larger than those found in our temperature reconstruction and two independent reconstructions. The causality of the amplified GCM temperature trends is examined. The sign of the GCM trends with respect to trends in the Southern Hemisphere Annular Mode (SAM) is opposite from what has been observed recently over continental Antarctica. It is shown that the temperature response in the GCMs instead appears to be most-strongly linked to a strong increase in column water vapor over Antarctica.

Keywords: antarctica, ipcc, gcm

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JMS018 **Oral Presentation** **1280**

Centennial southern annular mode behaviour in observations and IPCC AR4 models

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Andrew J. Monaghan, Martin Visbeck, Julie M. Jones, Phil D. Jones, Gareth J. Marshall, David H. Bromwich

Two techniques are used to reconstruct the long-term (1865-2005) variability of the leading mode of Southern Hemisphere atmospheric circulation, the Southern Hemisphere Annular Mode (SAM). Studies link upward trends in the SAM since the 1960s to climate changes across the Southern Hemisphere, specifically warming in the mid-latitudes (40o-60oS) and Antarctic Peninsula, and cooling across the Antarctic continent. The Peninsula warming trend is one of the strongest globally, exceeding 2oC in the last 50 years at Faraday/Vernadsky station, and is linked to recent ice shelf collapses. A number of modeling studies attribute the recent upward trends in the SAM to anthropogenic forcing from stratospheric ozone depletion and/or greenhouse gas (GHG) increases, both of which can cool the polar stratosphere and strengthen the polar vortex. Other studies recognize the role of natural forcing in modulating SAM variability. Given the climatic importance of the SAM, assessing whether the recent upward trends are outside the range of instrumentally-based past variability is necessary. Here we show that the seasonally reconstructed SAM has considerable multi-decadal variability, and only during the austral summer is the late-20th century positive SAM trend outside of the range variability over the last 140 years. The reconstructions are compared to the SAM inferred from 20th century global climate model simulations associated with the Intergovernmental Panel on Climate Change Fourth Assessment Report. Most models predict significant upward long-term trends that are not present in our instrumental-based reconstructions while failing to capture the strong recent upward trends in austral autumn. Our results indicate that realistic stratospheric ozone forcing is needed to adequately simulate long-term SAM variability and to accurately project SAM behaviour into the future.

Keywords: sam, reconstructions, ipcc

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1281**

Antarctic peninsula climate variability study

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Nikolay Ivanov

Recent numerical estimations of climate variability parameters for Southern Hemisphere indicate that the Western Antarctic Peninsula region is main hemispheric hot spot. This phenomena is traced in surface and troposphere warming trends, in prevailing large-scale circulation form, surface pressure decreasing, in sea ice retreat tendency, ozone decreasing, Antarctic Circumpolar warm water propagation over Peninsula shelf, land ice cover melting, in appearance of natural emissions of greenhouse gases from ornitogenic soils at sub-Antarctic Islands and so on. However, the Climate and General Circulation Models based on modern atmospheric trace gases content scenarios are not able to reproduce evident warming conditions near Antarctic Peninsula. Therefore, study of current and historic regional climatic variations based on observed data is very important for numerical model development using different relationships between Antarctic Climate System parameters. Some ideas for physical processes parameterisation can be obtained from diagnostic estimates of Antarctic Climate system parameters distribution and from their variability. The Antarctic Peninsula climate variability pictures based on manned stations data completed with SCAR READER (REference Antarctic Data for Environmental Research) Projects and SCAR King George Island Working Group information resources are presented. The results of the probabilistic analysis of comprehensive time series of surface air temperature, sea level pressure and other key climate parameters in this region undertaken for determining the inter-annual variability characteristics showing the annual cycle modulation by synoptic scale variability are demonstrated. Current meteorological, solar radiation, ozone, hydrological, sea ice, biological and greenhouse gases concentration data for total measurements period are used for unique local climate regime formation description. Statistical analysis of long term time series demonstrated that inter-annual tendencies of seasonal surface and troposphere temperatures over Antarctic Peninsula are more prominent than those observed in continental Antarctica. Results of prevailing large-scale atmospheric circulation forms and extra-tropical cyclone climatology parameters statistics obtained from AARI synoptic archive and NCEP/NCAR reanalysis are presented. Statistical characteristics of inter-annual variations parameters, annual rhythmics, synoptic scale processes and of diurnal course are calculated with account of low-frequency modulations in suggestion of stationary and periodic correlation. To parameterize the synoptic scale variability the model of stochastic impulse process is applied. It is demonstrated, that modulation component of inter-annual variability significantly exceeds variations of annual mean values (additive component of variability). The estimates of annual trends over different ranges of variability are provided. The statistical analysis of meteorological observations data at standard synoptic hours allowed to determine quantitatively the contribution of different time scale processes into formation of observed changes of climatic regime parameters of the surface atmospheric layer in the vicinity of the Antarctic Peninsula.

Keywords: climate change, estimation, trends

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1282**

The dependence of the structure of the NAM (Northern Annular Mode) on the polarity of ENSO

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We examine the dependence of the spatial structure of the Northern Annular Mode (NAM) on the polarity of ENSO, using both observations and a very large (150) ensemble of GCM simulations of the 1997/98 El Nio and 1998/99 La Nia events. The most important differences in the simulated NAM between warm and cold ENSO winters are found in the upper troposphere, where the NAM signature is enhanced during El Nio winters, particularly in the subtropics. These changes are consistent with a large and wide-spread increase in subseasonal variance of upper-level heights over the Atlantic sector during warm ENSO events (in contrast the impact of ENSO on the Pacific sector is much weaker). The more pronounced subtropical center of action of the NAM during warm ENSO winters is also consistent with ENSO-induced changes in the tropical upper level winds in the eastern Pacific, namely a weaker westerly duct during El Nio winters. This effect results in increased cross-equatorial propagation of midlatitude Rossby waves during La Nia winters and may also inhibit the propagation of wave activity from the Pacific into the Atlantic. A detailed comparison with observations will be presented.

Keywords: nam, enso

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS018 **Oral Presentation** **1283**

Arctic Ocean as an amplifier of arctic climate warming

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Oceanography Naval Postgraduate School IAPSO

Wieslaw Maslowski, Jaclyn Clement Kinney, Jaromir Jakacki

A high resolution coupled ice-ocean model of the Pan-Arctic region forced with realistic atmospheric data from ECMWF for 1979-2004 is used to investigate causes and variability trends of Arctic climate system. Recent warming in the Arctic has manifested itself most through the reduction of multiyear sea ice pack. It has been commonly associated with anomalies of surface air temperature and circulation over the Arctic . Those in turn have been linked to the Arctic Oscillation (AO). The main assumption of this approach is about the dominant role of external atmospheric forcing and the minimal effects of processes internal to the Arctic Ocean . In particular, the oceanic thermodynamic control of sea ice through the under-ice ablation and lateral melt along marginal ice zones has been overlooked. Our model results suggest that the significant portion of sea ice variability might be due to the increased advection of warm Atlantic and summer Pacific waters into the Arctic Ocean during the late 1990s and 2000s. Such ice-ocean interactions may not only act to melt sea ice but also to de-correlate AO forcing, which would help explain some of the forcing paradox between AO/atmospheric forcing and sea ice variability in the 2000s. In addition, we find that estimates of rate of sea ice melt using satellite-determined ice extent data might be too low as they account only for a two-dimensional change. We present model results to argue that changes in ice thickness and volume must be known to accurately quantify the rate of Arctic sea ice decline.

Keywords: arcitc climate, sea ice melt, modeling

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JMS018 **Poster presentation** **1284**

Geopotential height annual cycle in Antarctica: Year-to-Year variability and trends, 1980-2004

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The purpose of the present work is to detect trends in geopotential height for several mandatory reporting levels of the atmosphere over Antarctica within the period 1980-2004. In doing so, we attempt to analyze data from fifteen rawinsonde stations distributed all over the continent. Unfortunately, only eight stations fulfill the condition that its datasets cover the whole period. These stations are Amundsen-Scott (89009), Halley (89022), Novolazarevskaja (89512), Syowa (89532), Davis (89571), Mirnyj (89592), Casey (89611) and McMurdo (89664). Station 89009 is located in the South Pole, whereas station 89022 is located in Western Antarctica. The rest of the stations are located in Eastern Antarctica. The mandatory levels analyzed are 850, 700, 500, 400, 300, 250, 200, 150 and 100 hPa. Every set of twelve monthly means are year-to-year Fourier analyzed in order to obtain the following parameters for the first two harmonics: V1, V2 and the ratio A2/A1; V1 (V2) denotes the explained variance of the first (second) harmonic and A1 (A2) denotes the amplitude of the first (second) harmonic. Trends are detected by means of a parametric test and using a confidence level of 95%. If a trend is detected at any level, a linear regression is carried out to determine whether the trend is positive or negative. In general, results are as follows. As to V1, the lower levels of the troposphere are negative trended in the coastal region limited by 30W-120E. Regarding V2, negative trends are detected for the stratosphere in Western Antarctica. Concerning A2/A1, positive trends are detected for the lower levels of the troposphere in the coastal region limited by 30W-90E. For the lowest levels of the troposphere in this latter region, seeing that the value of A2/A1 is positive trended whilst the value of V1 possesses a negative trend, the explained variance for the first harmonic decreases favoring harmonics higher than the second, because no trends are detected for V2. Moreover, since V1 can be related to the presence of the polar vortex, it can be concluded from this research that its influence is decreasing in the lower levels of the atmosphere, at least in the coastal region limited by 30W-120E.

Keywords: geopotential height, trend, antarctica

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JMS018 **Poster presentation** **1285**

Associations between large-scale atmospheric circulation and polar mesocyclone developments over both hemispheres

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Polar mesocyclones are intense mesoscale weather systems which develop in response to combinations of upper-tropospheric vorticity advection, low-level baroclinicity near the sea ice-ocean margin and, especially in the northern hemisphere, strong air-sea thermodynamical fluxes. We evaluate the associations between dominant patterns of low-frequency variability in the atmospheric circulation (i.e., teleconnections) and polar mesocyclone developments over both hemispheres. Because polar mesocyclones are rather poorly represented in reanalyses, a number of synoptic variables related to mesocyclones are developed. These include the following : the temperature (T500) and geopotential height at 500hPa, the wind at 925 hPa, the SST, and the difference (SST-T500). In the northern hemisphere during winter, the North Atlantic Oscillation (NAO) has a strong impact on all these variables, but with strong regional and temporal dependence. Other teleconnection patterns also exhibit associations with polar mesocyclone developments. The Scandinavia pattern shows a strong negative association with the studied variables over the Norwegian and Barents Seas, but only marginally affects the Labrador Sea. The formation of polar mesocyclones is encouraged over the Norwegian and Greenland Seas when the Polar/Eurasia pattern is in its negative phase. In the southern hemisphere, polar mesocyclone environments show associations with the teleconnections to El Nio Southern Oscillation (ENSO) ; notably the Pacific-South America (PSA) and Antarctic Dipole (ADP) patterns represented over the south-east Pacific, Antarctic Peninsula and South Atlantic Oceans.

Keywords: mesocyclone, teleconnection

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JMS018 **Poster presentation** **1286**

Moisture transport to Syowa Station and Dome Fuji Station, Antarctica

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In order to see the characteristics of the air transport routes to Syowa station and Dome Fuji station, we assort backward trajectories using the cloudiness and other weather information obtained by ground-based observations. Based upon the results, we compare the transport routes on clear days and snow days at each station. At Syowa Station, on snow days, trajectories come from the Atlantic Ocean without any relation to their arriving heights. In contrast, they arrive from the continental interior to the point of 850hPa on clear days. There is a low pressure area on the west of Syowa Station in the "snow condition", on the other hands, a low pressure area appears to the east of Syowa Station and the high pressure area over Syowa Station in the "clear condition". It is suggested that the moisture is mainly brought to Syowa Station from Atlantic Ocean closely associated with the activity of disturbances. As for Dome Fuji Station, trajectory comes from every direction in both cases of "snow condition" and "clear condition". Any remarkable difference between "snow condition" and "clear condition" is not found in the distribution charts of trajectories. However, a high pressure area appears over Dome Fuji Station in the snow condition that would bring the warm advections into the continental interior. In order to explain moisture transport routes further, we made another criterion to collect the case of heavy snowfall. Transport routes with records as blizzard and heavy snowfall have remarkable characteristics. Air parcels come from Atlantic Ocean and Indian Ocean with rapid upward advections before arriving at the station. It is considered that we might have obtained typical moisture transport routes into Antarctica.

Keywords: trajectory, antarctic, water vapor

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JMS018 **Poster presentation** **1287**

Planetary and synoptic scale adjustment of the Arctic atmosphere to sea ice cover changes

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By means of unforced simulations with an AOGCM it is shown that naturally occurring changes between high and low sea ice cover phases of the Arctic Ocean exert a strong influence on the Northern Hemisphere storm tracks. Two slices with high and low sea ice cover have been analyzed with respect to the feedbacks between the time-mean flow, the quasi-stationary planetary and the baroclinic waves. The wave energy fluxes on time scales 2 to 6 days increase in the middle troposphere between 30 and 60o N during the high sea ice phase and force the enhanced zonal wind. Their increase is compensated by a strong reduction in the Eliassen-Palm fluxes on time scales from 10 to 90 days between 60 and 70o N during high sea ice phases, accompanied by reduced zonal west winds. High sea ice cover phases resemble zonal wind changes during the positive phases of the Arctic Oscillation (AO) especially over the northern part of the Atlantic Ocean. This result emphasizes the nonlinear dynamical feedback between Arctic sea ice cover and the AO-like atmospheric response in dependence of the wintertime sea ice distribution.

Keywords: arctic oscillation, sea ice, eliassen palm fluxes

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JMS018 **Poster presentation** **1288**

Long-Term Variability of Free Atmosphere in the Polar Regions

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New analyses of recently compiled time series of monthly mean parameters representing conditions of free atmosphere in the Arctic and Antarctic for 1959 2005 shows: - spatial distribution of the air temperature trends in the Arctic is inhomogeneous. Its are positive in the lower troposphere and negative higher 70hPa, especially above Northern Europe. This is probably because of the observed decrease in total ozone content and increase of greenhouse gases concentration; - annual mean air temperature anomalies averaged for the Arctic and Antarctic manifested warming in the upper troposphere and significant cooling in the low stratosphere in the Arctic, compare to very weak cooling of low stratosphere in the Antarctic. These data are in some disagreement with results of GCMs; - specific humidity trends are positive in the Canadian sector and negative over Eurasian part of the Arctic. It could result to increase of radiation cooling over Eurasian Arctic and decrease over Canadian sector; Our analyses of sounding data, obtained at seven polar stations surrounding East-Siberian Region and 30 drifting stations North Pole showed negative trends of surface based inversion height and positive trends of inversion strength during 1960s - 1980s, accompanied by negative trends of total cloudiness, surface air pressure, and positive trends of surface air temperature. These trends are in some agreement with observed long-term variability of the atmospheric circulation in the region under study and variations of heat advection in the low troposphere.

Keywords: variability, polar, atmosphere

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JMS018 **Poster presentation** **1289**

Current upper-air parameters trends over Antarctic

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The troposphere and stratosphere over Antarctica is characterised by specific features in comparison with the conditions of other climatic zones. These features include extreme climatic events, powerful spring stratospheric warming, a unique dynamic regime of a strong circumpolar vortex, special conditions of the radiation energy exchange and physical-chemical transformations in the atmosphere related to ozone dynamics. Significant experience of upper-air sounding carried out at Russian (Soviet) Antarctic stations is presently summarised in the atmospheric module of Geographic Information System The Antarctic, which is based on available observation data over the total period of instrumental measurements and aimed to a numerical analysis of the current and historic climate conditions of Antarctica. Initial data control allowed to fill the gaps in operational information and to remove random and systematic errors leading to inhomogeneity of the initial data sets using the information about the statistical structure of the upper-air parameter fields and metadata. Joint analysis of temperature, geopotential, humidity, wind speed and cloudiness is based on following upper-air datasets: CARDS, AARI database and SCAR information resources. Surface warming over Antarctic Peninsula is accompanied by changes in sea ice extent, changes in main atmospheric parameters of troposphere (warming in the troposphere, increasing of water vapour amount observed in the middle troposphere), and also by increasing of cyclone frequency and prevailing changes of cloudiness vertical macrostructure. The coincidence of the tendencies of the interannual variability of the dynamic Antarctic Oscillation index and the thermal regime parameters of the atmosphere above the Antarctic Peninsula indicates that the pronounced regional warming can be related to the prevailing changes in the circulation conditions of the Southern Hemisphere. Estimates of upper-air trends for different Antarctic areas are presented. Comparison of estimations of trend values, obtained by different methods on the base of CARDS and AARI data sets, has shown their consistency. Application of different methods for estimations of the trend values has shown that new presented robust method, based on the using of hourly observed values with provision for correlation dependence in time (points method), presents the possibility to estimate of trends values more accurate in comparison with the traditional approach of trend estimation. Research reveals: trend error determination for points method is less than for months method and therefore statistical significance of trend can be determined more carefully; points method gives the possibility of getting much smoother trend profiles and this is likelihood; points method estimation results are less sensitive to the time series length.. This is important for investigation of climate change of Polar Regions of the Earth due to difficult weather observation conditions at these regions. The creation of comprehensive Russian Antarctic stations upper-air dataset was supported by SCAR READER Project and Russian Program Study and Investigation of Antarctica.

Keywords: climate, trend, estimation

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JMS019 **1290 - 1305**

Symposium
Toward Bridging the Gap Between Weather and Inter-Annual Climate Variability: Processes, Phenomena and Prediction

Convener : Prof. Huw Davies

Improvement on the one hand in our understanding of persistent weather patterns and the continuing progress in deterministic and ensemble weather prediction has been paralleled on the other hand by the identification of key patterns of intra-seasonal and inter-annual climate variability and the development of operational suites for seasonal prediction. These advances have also pinpointed the role and significance of the oceans and land-surface processes to the understanding and forecasting of the phenomena and patterns. This Inter-Association Symposium will focus on the efforts being made to bridge the Weather - Climate Variability divide reflected in our understanding of the inter-play of the ocean, land and atmosphere, of the dynamics of the major phenomena, and in development of seamless prediction suites

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JMS019 **Oral Presentation** **1290**

Co-existence of chaos and order in the weather and climate dynamics

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After seminal works of Ed Lorenz almost all meteorologists agree weather variations of all scales are chaotic, i.e. unstable and unpredictable for more or less distant future. Moreover, the same opinion is widely accepted as concern climate variations. My aim is to discuss another opinion that chaos and order co-exists in the weather and climate dynamics. Certainly, weather variations are chaotic mainly, but even these are mutually ordered in part, and so a new approach to the extended weather forecasting will be demonstrated that takes into consideration an order in weather variations of the weekly-monthly time periods. The supposition that climatic variations are nonchaotic can be motivated by the existence of the lower-frequency end of the inverse energy cascade in the atmospheric macroturbulence. This end is an obstacle for propagation of the higher-frequency atmospheric fluctuations to the seasonal and longer time scales. By this reason the famous Lorenzs up-scale propagation of the forecasting model errors also must be limited by this end. Thus, the present-day ensemble approach to the seasonal forecasting problem can be under question. The mathematical notion of the so-called STRANGE NONCHAOTIC ATTRACTOR (SNA) is very important in this context. SNA is a tool to catch well aperiodic variations in quasiperiodically forced nonlinear dynamical systems. Instead of chaos, SNA reveals heavy rhythms at the force frequencies and their combinational harmonics even if the magnitudes of the forces are quite small. As a result, the power spectra of such SNA-like variations consist of innumerable power-energy peaks and bands of increased energy superimposed on an apparent continuous noisy-like background. It is important that SNA-like climatic variations can be predictable without any limit like the well-known atmospheric and oceanic tides.

Keywords: weather and climate, chaos and order, nonlinearity

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JMS019 **Oral Presentation** **1291**

Verification of Hemispheric-Wide Winter Temperature Forecasts Based on Fall Snow and Atmospheric Anomalies

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Christopher Fletcher

One outstanding issue in seasonal climate prediction is whether there is any robust predictability beyond ENSO dynamics. We have operationally produced real-time winter forecasts for the US based on fall Eurasian snow cover and atmospheric anomalies for the past seven years. Operational forecasts have been expanded to include Europe for the past three years and East Asia for the past two winters. In addition, hindcasts have been produced for the winters 1972/73-2004/05. Here we assess the skill of these forecasts, up through the most recent winter season. These snow-based forecasts appear to provide considerable additional information beyond the standard-ENSO based forecasts and even the most sophisticated dynamical models.

Keywords: predictability, forecasting, prediction

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JMS019 **Oral Presentation** **1292**

Nonlinear error dynamics and the study of climate predictability

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Jianping Li

Since atmosphere itself is a complex nonlinear system, there exist a lot of limitations using the linearized error growth equations to study the atmospheric predictability. It is necessary to propose a new approach based on nonlinear error dynamics for quantifying the atmospheric predictability. In this paper, we first applied nonlinear error growth equations of nonlinear dynamical system instead of linear approximation equations to discuss the evolution of initial perturbations, and introduced the concept of nonlinear finite-time Lyapunov exponent (FTLE), which is a nonlinear generalization to the existing local or finite-time Lyapunov exponents. With the nonlinear FTLE and its derivatives, the results indicated that the predictability limit of chaotic system can be quantitatively determined and the limitations of traditional Lyapunov theory in quantifying the predictability can be efficiently overcome. Then, based on above theory, we present a reasonable algorithm that allows the estimation of climate predictability from atmospheric observation data. It is found that the predictability of 500-hPa monthly mean geopotential height field is high in the tropics but low in the extratropics. In the tropics, the limit of monthly predictability is generally about 6~8 months. However, in the extratropics, the limit of monthly predictability is only about 1~2 months. In addition, monthly predictability varies with the seasons. For the most regions in the Northern and Southern Hemisphere, the monthly predictability in winter is higher than that in summer, especially over the north Pacific, north Atlantic and Antarctica. These results have potential application in the assessment of prediction skill of climate prediction system.

Keywords: predicability, climate, lyapunov exponent

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JMS019 **Oral Presentation** **1293**

What's inside a monthly mean data point? Examination of tropical column data

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High resolution (hourly or finer) column datasets, from both observations and models, have been assembled for multiple sites mainly in the tropics. Monthly means are used to categorize climate regimes. Within these regimes, submonthly variability is examined in detailed samples, and characterized statistically using regression and composite analysis. In terms of deep convective weather event life cycles, models are strikingly diverse. Grid-resolved saturation events have a very different character than parameterized convective events. All differ substantially from observations and obs-forced cloud models, which are fairly consistent among themselves.

Keywords: convection, tropical, gcm

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JMS019 **Oral Presentation** **1294**

Quasi-Equilibrium from Small Scales to Large: The Vertical Structure of Temperature and Moisture Perturbations in the Tropics

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J. David Neelin

To investigate dominant vertical structures of observed temperature perturbations, and to test the temperature implications of the convective quasi-equilibrium hypothesis, the relationship of the tropical temperature profile to the average free tropospheric temperature is examined in Atmospheric Infrared Sounder (AIRS) satellite data, radiosonde observations, and National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis. The spatial scales analyzed extend from the entire tropics down to a single reanalysis grid point or radiosonde station, with monthly to daily time scales. There is very high vertical coherence of free tropospheric temperature perturbations. There is also fairly good agreement throughout the free troposphere between observations and a theoretical quasi-equilibrium perturbation profile calculated from a distribution of moist adiabats. Overall, there is much higher agreement with quasi-equilibrium theory throughout the free troposphere than has been shown in previous observational studies comparing free tropospheric temperature perturbations to changes in the boundary layer moist static energy. The boundary layer in this study is fairly independent from the free troposphere, especially for smaller scales. A third vertical feature of the temperature perturbation profile, besides the fairly coherent free troposphere and somewhat independent boundary layer, is what we call the "convective cold top:" a robust negative correlation between temperature perturbations of the vertically averaged free troposphere and those of the upper troposphere and lower stratosphere. One simple explanation is proposed: hydrostatic pressure gradients from tropospheric warming extend above the heating, forcing ascent and adiabatic cooling. The negative temperature anomalies thus created are necessary for anomalous pressure gradients to diminish with height. A related question is: how much can precipitation be determined, at least in a statistical sense, by column average water vapor? A recent study has shown a power law relationship between these quantities above some critical threshold, and an exponential pickup below critical. This relationship is analyzed in radiosonde data, and profiles of water vapor and relative humidity are averaged over bins with different precipitation and column water vapor amounts to investigate the changes in the vertical structure of moisture as critical values are approached.

Keywords: convection, quasi equilibrium, tropics

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JMS019 **Oral Presentation** **1295**

Climate change in the tropics induced by indian weather events

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Claire Perigaud

We investigate the impact of sub-monthly Indian wind and rain fluctuations on the climate variations of the tropical Ocean/Atmosphere/Land System. A three-year record of daily fluctuations of observed precipitation from TRMM and wind from QuikSCAT since Jan 1st 2000 are used to force an Indian Ocean model in twin experiments that differ only by their forcing, which is either daily- (Exp_day) or monthly- (Exp_month) averaged. Results show that sub-monthly forcing have a significant impact on intra-seasonal to inter-annual variability of the ocean. For instance, daily wind fluctuations enhance the Sea Level variability at 60 days, in better agreement with the altimetric observations from TOPEX-Jason. Daily rain fluctuations modify the Salinity mostly in the Bay of Bengal once per year during the wet season from May to November: the Andaman Sea is saltier by as much as 1.3 psu for Exp_day. The frequency shift between the sub-monthly rain forcing and the yearly salinity response is due to accumulation in time of nonlinear mechanisms: during the wet season, sudden rain deficits increase the SLS by entraining salty waters from below, whereas rain excesses are inefficient to decrease the salinity of the thick surface layer. In addition, wind and rain sub-monthly fluctuations impact the seasonal cooling and warming of the surface ocean south of the equator. We present the associated atmospheric response at various time scales.

Keywords: indian climate variability, trmm quikscat indian ocean, weather climate interaction

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JMS019 **Oral Presentation** **1296**

Summer and Winter seasonal temperature lags: a comparison of regional patterns in Chile and Australia

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x IAMAS

Ian Smith, Claudia Villarroel Jimenez

The lag of the seasons is a very useful indicator of the variability of the annual seasonal cycle. We present an analysis of this lag for both the summer and winter seasons for the period 1962-2005 for 12 stations in Chile and 8 stations in Australia, where high quality daily temperature series are available. The technique fits an annual Fourier mode over a half year of daily data centred approximately on the summer maximum and the winter minimum temperatures, from which the dates of the maximum and minimum in the annual cycle can be accurately determined.The results show that generally the summer lags are somewhat greater than the winter lags, and interestingly that the trends in the summer lags in Australia, and in the winter lags in Chile are the most significant. The inter-annual variability in lag is found to be spatially coherent in both countries over extended regions.The reasons for these patterns will be discussed, and also the importance of trends in lag as a component of the global warming signature in the window between weather and climate.

Keywords: seasonality, australia chile, climate change

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JMS019 **Oral Presentation** **1297**

The seamless weather-climate prediction problem

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The nature of the seamless weather-climate prediction problem will be discussed. Examples will be given of particular phenomena that illustrate the interactions between differing time-scales. Activities initiated by the international programmes WCRP and THORPEX that are aimed at working towards a common attack on relevant scientific problems will be described.

Keywords: wcrp, thorpex, time scales

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JMS019 **Oral Presentation** **1298**

Atmospheric blocking and its space-time links to inter-annual climate variability

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Mischa Croci-Maspoli, Huw C. Davies

Understanding the dynamics through which shorter-term weather processes underly and partly control large-scale climate variability patterns is central to accurate seasonal and climate prediction. Blocking is a large-scale and persistent weather phenomenon that occurs in areas where the major ocean-atmospheric variability patterns (NAO, PNA) are recorded. It is associated to dramatic shifts in flow conditions, cyclone tracks, precipitation and radiation. Here we investigate the space-time relationship of the physical phenomenon of blocking to the statistically-derived variability patterns. These climatological analyses are undertaken using the ECMWF ERA40 data set. The novel blocking climatology provides information on the full life cycle and renders possible cause-and-effect investigations on a 6-hourly basis. The main results from this comprehensive study are: Blocking frequencies are doubled during the negative phases of the respective variability patterns, and temporal co-variability of the phenomena points to a strong space-time dependence. Genesis and lysis areas, and also blocking tracks differ fundamentally for the different pattern variability phases, while the amplitude and area of blocking is not related. An EOF analysis provides evidence that the importance and location of the veriability patterns in the Atlantic is controlled significantly by blocking. An analysis of the pattern phase changes reveals that blocking can trigger a change into the negative NAO phase in almost 60% of the cases. The PNA variability is less related to the blocking phenomenon. Finally, blocking trends throughout the ERA40 period are significant, especially over the Atlantic-Europea region in the winter and spring seasons. Together these results point to a strong linkage of the climate variability patterns with the weather phenomenon of blocking. The results have implications for predictability issues on both the medium and extended range. In particular, an under- or misrepresentation of blocking in weather and climate models can significantly influence the models'accuracy, since the location and amplitude of the patterns change. And the detected trend in blocking points to a regime shift in climate variability in these areas.

Keywords: blocking, predictability, thorpex

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JMS019 **Oral Presentation** **1299**

On the downstream influence of the tropical Pacific on mid-latitude high-impact weather forecasting from weeks to seasons.

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Dr. Hai Lin, Bertrand Denis, Prof. Jacques Derome

Internationally, the increasing demand for accurate high-impact weather-environmental forecasts has led to significant investment in Numerical Weather Prediction (NWP), more specifically in high performance computing, high-speed telecommunication, ground-, space- and aircraft-based measurement technologies, systematic observations, remote sensing, field and laboratory process studies, data assimilation techniques, and in highly performing coupled numerical models of weather and climate prediction. The challenge today is to further improve the existing forecast and diagnostic products, to increase their economic and societal values and to broaden their suite of applications through the development of a seamless prediction process that eliminates the long existing separation of the weather and climate forecast processes. The tropical Pacific is identified as one of the most crucial regions for improving mid-latitude forecasts in a seamless way from weeks to seasons. One of the challenges for second week prediction is to advance forecasting of small-scale convection phenomena that have large-scale impact on the mid-latitudes through inverse energy cascade effects, such as the MJO phenomenon and planetary propagation of Rossby wave packets. NWP R&D activities will require increased model resolution, deeper vertical extension, and improved microphysics in order to improve forecasts of the MJO. The MJO is a multi-scale convection problem, involving dynamical processes that organize deep convection on scales ranging from a few kilometers to thousands of kilometers: i.e., from storm-scale to regional-scale to large-scale. The hierarchical organization of tropical convection is known to excite Rossby wave packets in ways that are not fully understood. This work through a combination of numerical modeling at high horizontal resolution and dynamical analysis will seek to quantify how the MJO excites Rossby wave packets. This work is a path toward a future numerical forecasting strategy involving tropical-mid-latitude dynamical interaction and predictability. The proposed forecasting strategy could be an operational reality in the next decade. One of the challenges for seasonal forecasts is to capture the tropical Pacific signal correctly and to convert it into a mid-latitude meaningful response for surface temperature and precipitation. In the second phase of the Canadian Historical Forecasting Project (HFP2), four global atmospheric models (GCMs) were used to perform seasonal forecasts over the period 1969-2003. Good skill was obtained for surface temperature, but little predictive skill was found from the GCM ensemble seasonal predictions for the Canadian winter precipitation. Canadian winter precipitation is significantly influenced by two of the most important atmospheric large scales patterns, namely, the Pacific-North American pattern (PNA) and the North Atlantic Oscillation (NAO). The time variation of these two patterns were found to be significantly correlated with those of the leading singular value decomposition (SVD) modes that relate the ensemble mean forecast 500 hPa geopotential height over the Northern Hemisphere and the tropical Pacific SST in the previous month (November). More specifically, we will show that the ensemble mean forecast NAO and PNA indices respond relatively well to the tropical forcing, but it is the ensemble mean forecast NAO pattern that is significantly distorted and makes deficient the precipitation forecast over Canada.

Keywords: numerical weather prediction, ensemble forecast, intra seasonal variability

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JMS019 **Oral Presentation** **1300**

Use of satellite data and weather typing methods to understand time-scale interactions in the Indian Ocean climate

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Claire Perigaud, Julien Boe, Julien Najac, Serena Illig

Separating weather and climate timescales for prediction and associated physical mechanisms is very often artificial and misleading. Here we investigate the role of daily atmospheric fluctuations in setting low fluctuations in the Indian Ocean climate, based on six continuous years of satellite data and the use of Intermediate Complexity Models. Spectral studies show that about 80% (55%) of the precipitation (wind) variability estimated from TRMM (QuikSCAT) occurs in the daily band (2-30 day range) on average over the basin. By contrast, sea level variability estimated by satellite altimetry (Topex-Jason, ERS) suggests that most of the variance (95%) occurs above 40 days with energy peaks associated with Madden Julian (MJO) fluctuations and oceanic basin-resonnant signals. We perform two distinct ocean experiments either forced by wind and precipitation satellite daily fields over 2000-2005, or forced by their monthly averages. We conclude that daily fluctuations are mandatory to correctly reproduce the observed Indian Ocean variability in terms of sea level, sea surface temperature and sea surface salinity. We show that the intra-seasonal to inter-annual ocean variability is fed by higher frequency atmospheric fluctuations which, when monthly averaged, leads to a clear underestimation of the simulated low frequency variance by about 50%. This study highlights the crucial need for continuous and very accurate satellite data as well as a good representation of daily variability for surface variables estimated from atmospheric model or reanalysis products. Comparing the latter to satellite datasets shows a clear underestimation of the wind and rainfall variability while large-scale patterns are correctly represented in models. A preliminary and ongoing study based on classification techniques applied to daily TRMM and QuikSCAT data suggests that weather patterns or regimes can be linked to large-scale and lower frequency atmospheric fluctuations such as the MJO or monsoons entities (break etc.). This dynamical view of the tropical dynamics, or transfer function between time and space scale, establishes a bridge between weather and climate atmospheric structures could provide a more accurate forcing for ocean models compared to traditional monthly averaged fields.

Keywords: time scale, interaction, regimes

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JMS019 **Oral Presentation** **1301**

Potential and actual predictability of Indian monsoon rainfall derived from DEMETER using a Tie r 1.5 approach

Dr. Annalisa Bracco
Earth and Atmospheric Sciences Georgia Institute of Technology

The potential for predictability of the Indian Summer Monsoon rainfalls (IMR) during the second half of the XX century is investigated comparing the original coupled model hindcasts from the DEMETER project with hindcasts generated using a 'Tier 1.5' approach. The expression 'Tier 1.5' describes an ensemble generated by using DEMETER sea surface temperature (SST) anomalies to force an atmospherical general circulation model (AGCM) everywhere except in the Indian Ocean (IO) region, where a dynamical ocean model is coupled to the AGCM. Experiments performed using a 'Tier 2' approach, in which observed SST anomalies are prescribed everywhere, are also considered. Furthermore, potential and actual correlation skill scores from the circulation models are compared with results from an empirical model. The Tier 1.5 approach considerably improves the hindcasts.

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JMS019 **Poster presentation** **1302**

Developments of the ECMWF ensemble system

Dr. Roberto Buizza
Research Department ECMWF

Martin Leutbecher

In September 2006, the 15-day Variable Resolution Ensemble Prediction System (VAREPS) was implemented in the European Centre for Medium-Range Weather Forecasts (ECMWF) operational suite. VAREPS is a system designed to provide skilful predictions of small-scale, severe-weather events in the early forecast range, and accurate forecast large-scale guidance in the medium forecast range up to 15 days. In the first part of this talk, the rationale behind VAREPS is presented, and the performance of an earlier VAREPS configuration is compared to the performance of two constant resolution systems, a TL255L40 and a TL319L40 (this latter one requires similar computing resources to VAREPS). Average results based on up-to 111 cases indicate that VAREPS has a higher forecast-time integrated forecast skill, and it provides significantly better forecasts in the early forecast range without loosing accuracy in the long forecast range. The implementation of the 15-day VAREPS is the second phase of 3-phases upgrade of the ECMWF ensemble system that will lead to a seamless ensemble system ranging from the medium-range to the monthly time scale: the first phase was the resolution increase (from TL255L40 to TL399L62) implemented in February 2006, and the third phase will be the merging of the 15-day VAREPS with the monthly forecasting system to provide weekly 32-day coupled ensemble predictions. Future changes in the ECMWF ensemble system might include a revision of the method used to define the initial perturbations using an ensemble of analyses generated by perturbing observations in data-assimilation cycles. In the second part of this talk, recent results on the use of ensemble of analyses in the ECMWF ensemble prediction system will be reviewed and discussed.

Keywords: predictability, ensemble, assimilation

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JMS019 **Poster presentation** **1303**

Impacts of forced sub-tropical waves on extra-tropical flow: Theory and Model Simulations

Mr. Thomas Spengler
Institute for Atmospheric and Climate Research ETH Zurich

Jana Campa, Huw C. Davies

The study is built around two linked aspects. First that events of intense localized convective activity in the sub-tropics (such as the MJO) can constitute a large-amplitude coherent flow feature in an otherwise comparatively quiescent ambient environment. Second that such sub-tropical synoptic-scale perturbations can play a major role in the initiation of Rossby wave trains in the extratropics, and in particular trigger downstream development along the PV wave-guide. In this study the influence of such subtropical/tropical forcing upon extra-tropical flow is studied using a mix of theoretical considerations and idealized model simulations. Theoretical considerations indicate the sensitive dependence of latitudinal wave-transmission to the ambient atmospheric state and zonal structure of the forcing. Lateral propagability is drastically reduced in stronger shear flow. For realistic atmospheric settings meridional propagation is expected to be highly evanescent. In addition numerical simulations, performed with the ECMWF Integrated Forecast System (IFS CY31R2), pinpoint further dynamical aspects of lateral wave propagation. The model was initialized with an idealized zonally symmetric, barotropic jet with variable strength. A mountain located at different, tropical and subtropical latitudes was used as a trigger for stationary waves. The impact on the extra-tropical flow can be separated into two regimes: Downstream development along the jet-steam (wave-guide) and Rossby wave propagation along great circles. First is evident for all experiments, whereas latter is highly dependent on jet-strength, location of forcing and time. The results suggest that for medium range prediction (up to day 15) only downstream development along the wave guide is of relevance, whereas wave propagation along great circles is limited to weaker jet settings and long lasting forcing events, hence becoming more relevant on seasonal time-scales.

Keywords: rossby wave, pv wave guide, downstream development

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JMS019 **Poster presentation** **1304**

How do weather, insolation, and interannual phenomena affect spectral slopes of climate variables?

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DIVISION OF OCEAN AND CLIMATE PHYSICS Lamont-Doherty Earth Observatory, Columbia U

Alexey Kaplan

Spectral slope is a widely-used statistic in climatology that summarizes the redness oftime series. Links between the strength of the annual cycle and spectral slope for surface temperatures have been suggested recently in literature. We propose the ratio of interannual to subannual variance (climate-to-weather ratio) as an analogous metric to the spectral slope and define the exact correspondence between the two measures. This ratio is fundamentally a calculation of the power law with spectra binned and averaged in two uneven frequency intervals divided at annual frequency. We extend our analyses to sea surface temperature and height, sea level pressure, and precipitation. First, we evaluate the impact on the spectral slope of subseasonal, subannual, and interannual phenomena and assess the contribution of other factors. Second, we use the method of empirical orthogonal functions to measure the contributions of individual interannual variability modes. Finally, we evaluate the impact of insolation forcing on spectral slope and discuss the mechanisms by which this role could be performed.

Keywords: interannual, variability, spectral

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JMS019 **Poster presentation** **1305**

Breaking waves on the tropopause and their relation to inter-annual climate variability

Dr. Conny Schwierz
School of Earth and Environment University of Leeds IAMAS

Olivia Martius, Huw C. Davies

Waves on the tropopause are an ubiquitous feature of atmospheric flow. When they break, they form elongated structures (streamers) that correspond to deep and narrow intrusions of stratospheric air into the troposphere and vice versa. The propagation and breaking of these waves is closely related to the evolution of cyclones and severe weather such as heavy precipitation and sand storms. It has also been suggested that the formation of lower-frequency phenomena, such as blocking and the major large-scale variability patterns (NAO, PNA) can result from a succession of forward (cyclonic, LC2) and backward (anticyclonic, LC1) breaking waves. Here we introduce a 6-hourly climatology of such waves and the resulting streamers derived from the ECMWF ERA40 data set. We present a methodology to identify the form of the streamers (LC1, LC2) and study the linkages to the major climate variability patterns of the northern hemisphere. An overview is provided on where (zonally) and when (seasonally) the short-term variability throughout the extra-tropical and sub-tropical tropopause is enhanced or reduced. Several key processes that influence this variability are discussed. Baroclinic processes for example determine the variability in the storm-track areas in winter, where as the Asian summer monsoon significantly influences the variability over Asia. In a second part links are sought between three major northern hemisphere teleconnection patterns and the frequency of streamers throughout the extra-tropical and subtropical tropopause. The observed changes in the streamer frequencies are closely related to concomittant variations in the tropopause distribution of PV and its gradient. During opposite phases of the North Atlantic Oscillation the location of the streamer frequency maxima shifts significantly in the Atlantic and European region, both in the extra-tropics and the subtropics. The influence of ENSO on the streamer frequencies is most pronounced in the subtropical Pacific.It is shown that the occurrence of cyclonic and anticyclonic streamers (LC1, LC2) exhibits a distinct spatial variability in the horizontal and the vertical. The majority of cyclonic streamers is found on lower isentropic levels that intersect the tropopause at more poleward latitudes, whereas anticyclonic streamers predominate at higher elevations in the subtropics. An analysis of the streamer patterns for the two phases of the NAO reveals significant differences in the location and frequency of both cyclonic and anticyclonic streamers in the Euro-Atlantic region on the 310K isentropic level. Likewise for the two phases of the ENSO and the PNA there are marked differences in the frequency pattern of cyclonic streamers. An examination of the tropopause-level hemispheric flow pattern at the time of and prior to a streamers formation indicates a linkage to the presence or absence of double jet structures.The importance of these findings in relation to predictability issues of inter-annual climate variability is also discussed.

Keywords: streamers, predictability, thorpex

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JMS020 **1306 - 1329**

Symposium
Assessing & Exploiting Re-analysis Data Sets

Convener : Dr. Phillip Arkin
Co-Convener : Dr. Annarita Mariotti

The compilation of spatially and temporally consistent global data sets for atmosphere variables along with associated variables at the underlying surface (- such as SST, surface, wind stress, land surface state and soil moisture) has presented the environmental community with unprecedented opportunities. It has become possible to derive global budget estimates for a range of variables, to compile climatologies of a myriad of phenomena, and to undertake detailed diagnostic analyses of environmental processes. This Inter-Association symposium will aim at assessing the strengths and weaknesses of the data sets, highlight the progress made in diagnostic studies, and preview future developments

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JMS020 **Oral Presentation** **1306**

Atmospheric Analysis and Reanalysis: Current Capabilities and Future Directions

Dr. Phillip Arkin
Earth System Science Interdisciplinary Center University of Maryland IAMAS

Observations and models of the global atmosphere are more available and capable than ever before. However, our understanding of climate system variations and changes depends crucially on our ability to integrate the observations and models into complete descriptions, or analyses, of the atmosphere. In this presentation I will describe the evolution of atmospheric analysis techniques and the development and implementation of reanalysis as a vital resource for climate science. Atmospheric reanalyses in the U.S. and elsewhere have proven to be an exceptionally valuable tool for studying regional and global climate variability, and the continuation of atmospheric analyses, both regional and global, as Climate Data Assimilation Systems is essential to operational monitoring of such phenomena as El Nio. I will present the current status of atmospheric reanalysis activities and describe a proposed U.S. National Program for Earth System Analysis.

Keywords: reanalysis, climate, geoss

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JMS020 **Oral Presentation** **1307**

Precipitation Reconstruction Based on Satellite and In Situ Data

Dr. Thomas Smith
CICS CICSESSIC, U. Maryland IAMAS

Philip Arkin, Mathew Sapiano

Initial results of improved precipitation reconstructions are presented. Microwave-based satellite data are used to produce a monthly analysis beginning 1988. This satellite based analysis is blended with ECMWF reanalysis in locations where the microwave estimates are not available to produce a globally-complete analysis. The satellite-based reconstruction is used to form statistics to evaluate potential in situ based reconstructions for the pre-satellite period. Both direct and indirect in situ precipitation information are considered. Comparisons to an earlier in situ based reconstruction by Xie et al. are also evaluated.

Keywords: precipitation, reconstruction

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JMS020 **Oral Presentation** **1308**

Analysis of warm season convective regimes over Europe using MeteoSAT and NCEP reanalysis data

Dr. Vincenzo Levizzani
CNR ISAC IAMAS

Matteo Masotti, Roberto Ginnetti, Arlene Laing, Richard Carbone

A dataset consisting of 5 years of Meteosat IR data every half hour has been exploited to investigate the span and duration of convective system over Europe and the Mediterranean during summer months (May-August). Power spectra analysis was also conducted to assess the daily cycle of convection. The European domain was split in two parts to better identify the different latitudinal regimes, especially discriminating between the North Atlantic jet and the circulation from North Africa which interests the western and central Mediterranean. The northern and southern domains span 44-54 N and 30-44 N, respectively, and the longitude domain is 15 W - 40 E. May to August data were considered. The role of orography in determining the convection strength and propagation is evident. The Atlas, Pyrhenees, Alps and Carpatians heavily influence the circulation and convective cloud development. At the same time the propagation and convective re-generation component of the mesoscale systems is observed. An analysis of NCEP reanalysis data for the period is also conducted and first results presented. The study represents a first attempt to a systematic analysis of warm season convective precipitation systems over Europe within the World Weather Research Programme warm season study. These first results indicate the importance of a quantitative analysis of this kind to gain insights into organized system formation and evolution for a better short to medium term predictability. A longer term reanalyses of Meteosat data and a routine processing for the future is envisaged using precipitation products such as CMORPH.

Keywords: precipitation, satelllite meteorology, warm season

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JMS020 **Oral Presentation** **1309**

Reanalysis-based Precipitation Monitoring

Mr. Chester Ropelewski
IRI for Climate and Society Columbia University IAMAS

Michael Bell

Many applications-driven decision systems require some knowledge of up-to-date precipitation information on the sub-seasonal, sub-monthly, and in some cases, daily temporal scales. The requirements are not-only the latest estimates of rainfall but also for some estimates of how the current estimates compare to the historical record. The availability of consistent daily weather observations is limited in many parts of the world. The new generation of satellite-based precipitation estimates provides credible high-spatial resolution estimates of daily rainfall but these products have very short data records. In the future satellite-based rainfall estimates are likely to become the source of historical data as well as real-time precipitation estimates for climate monitoring. However, the need for consistent long record daily rainfall records is now. In this paper we investigate the usefulness of gridded station observations and model based Reanalyses as tools for monitoring daily rainfall and thus as a means for estimating the observed statistics of weather within climate. As a first step in the analysis the ENSO- related shifts in the observed histograms of daily precipitation in gridded station analysis are compared to the shifts in the NCEP/NCAR Reanalysis for South America. Statistically significant shifts in the daily histograms are identified using a Kolmogorov- Smirnov test. Preliminary comparisons suggest that while the Reanalysis does not ideally replicate the gridded station results the Reanalysis may be useful as a tool for indicating candidate regions for further analysis with gridded station data. Appropriate corrections to the Reanalysis rainfall estimates will be developed and tested.

Keywords: precipitation, monitoring, estimates

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JMS020 **Oral Presentation** **1310**

How useful are re-analyses in describing interannual oceanic precipitation anomalies?

Dr. Annarita Mariotti
ESSIC UMD IAMAS

The influence of large-scale climate modes on interannual oceanic precipitation variability still remains to be fully described. Given the limited availability of observational oceanic precipitation estimates, atmospheric re-analyses remain the primary source of comprehensive data on the atmospheric water budget, independent from the satellite based products. Although in current re-analyses precipitation is model-derived, quantities on which the model calculation is based, such as temperature, humidity and sea level pressure, are nudged to observations. This talk will discuss the usefulness of re-analyses in describing the impact of large-scale modes such as the North Atlantic Oscillation on oceanic precipitation variability. Results from re-analyses will be compared state-of-the-art global precipitation datasets. The robustness of the precipitation features will be substantiated by the investigation of the associated anomalous circulation.

Keywords: oceanic, precipitation, variability

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JMS020 **Oral Presentation** **1311**

North american regional reanalysis: strengths, weaknesses, applications; what have we learned from a

Dr. Fedor Mesinger
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Kenneth Mitchell, Geoff Dimego, Eugenia Kalnay, Ernesto H. Berbery

The NCEP North American Regional Reanalysis (NARR) project had a clear foremost objective: to create a long-term, consistent, high resolution climate dataset for the North American domain as a major improvement upon the earlier global reanalyses in both resolution and accuracy. The assessment of the authors of the NARR AMS Bulletin paper was that this objective has been fully met. Precipitation assimilation, the first in a reanalysis project, resulted in precipitation fields very near those of the ingested precipitation analyses, ensuring that over regions with reasonable density of gauge observations, the hydrological cycle is more realistic than if the model was free to forecast precipitation. With respect to fits to data, not only have the near-surface temperatures and winds been shown to be closer to the observations than those of the NCEP/DOE Global Reanalysis (GR2), as one would expect, but very substantial improvements in the accuracy of winds and temperatures throughout the troposphere have been demonstrated as well. Precipitation assimilation performed extremely well over areas having a reasonable spatial density of gauge observations such as the Continental United States. However, areas of sparse gauge coverage, and those of low space-time resolution CMAP analyses over low-latitude ocean areas, might have done better with the model predicted precipitation instead. With the benefit of hindsight, several features of the Eta 3DVAR data assimilation system (EDAS) used can be changed or explored with excellent prospects for a still better result. Still, overall, a dataset of unprecedented quality over the primary region of interest has been obtained, and is extensively used at the time of this writing. Highlights of a number of applications will be summarized at the presentation time. As an example, a study established that in order for seasonal precipitation anomalies to emerge in response to soil moisture anomalies in a given region, it is necessary that the region's seasonal climate not be too dry or too wet. Other moisture and energy budget studies have led to results not achievable using available global reanalysis datasets. Several initiatives are in progress or are considered of mounting other regional reanalysis projects. Experience of NARR shows that a regional reanalysis is a cost-beneficial option of obtaining high-quality climate data for a region of interest. A number of lessons learned points at ways to do still better in these expected or possible future efforts.

Keywords: regional reanalysis, climate datasets, land surface

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JMS020 **Oral Presentation** **1312**

Seasonal and Interannual Variations of Fresh Water Flux over Global Oceans in the NCEP CDAS, CDAS2, GDAS, GFS, and CFS

Dr. Pingping Xie
DOC CPCNCEPNOAA IAMAS

John E. Janowiak, Mingyue Chen, Chung-Lin, Shie, Long Chiu

Seasonal and interannual variations of global oceanic precipitation and evaporation generated by the NCEP CDAS, CDAS2, GDAS, GFS AMIP runs, and the CFS coupled simulations have been examined and compared with those of the observations from CMAP and GSSTF2. In general, large-scale distribution and seasonal variation patterns of global oceanic precipitation, evaporation and fresh water flux are relatively well re-produced by the NCEP reanalyses and the climate models. Systematic differences, however, are observed in the magnitude of the precipitation and evaporation compared to the CMAP and GSSTF2. For instance, both the precipitation and the evaporation in the CDAS2 are over-produced, while their differences (fresh water flux) are in general agreement with the observations over tropical and sub-tropical oceans. Interannual variability of precipitation and evaporation associated with the ENSO, NAO, AO and PNA is reasonably well captured in the reanalyses and model simulations examined here. Quantitative agreements between the reanalyses and the observations, however, are less desirable, especially over tropical oceans. Monthly anomaly correlation between the NCEP reanalysis 2 (CDAS2) and observation is less than 0.4 for both precipitation and evaporation over most of the global tropical oceanic regions. Further work is underway to examine the surface wind, temperature, humidity and other related atmospheric and oceanic fields to better understand the differences with the observations and among the reanalyses and model simulations.

Keywords: precipitation, evaporation, re analysis

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JMS020 **Oral Presentation** **1313**

Comparison of basic fields in ERA-40 and NCEP/DOE Reanalysis II Datasets

Prof. Richard Grotjahn
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This presentation compares primary fields on a global scale from two popular reanalyses. The datasets are the ECMWF ERA-40 and the NCEP/DOE (NDRa2) reanalysis II. Significant differences found in the primary circulation variables and energetics will be emphasized. Some examples follow. i) Kinetic energy is greater in ERA40 data, mainly at the polar night jet, the subtropical jets, and in the equatorial mid-stratosphere. ii) During DJF zonal mean zonal wind, [u] has zonal mean upper troposphere tropical westerlies in ERA40, whereas NDRa2 has easterlies; this difference may imply a different amount of interhemispheric communication. iii) The surface energy budgets differ. ERA40 data have greater sensible heat flux into the air, while NDRa2 data have greater latent heat flux. So, NDRa2 has greater zonal mean specific humidity, [q] in the subtropics. iv) However, the Hadley-cell circulations are stronger in ERA-40. The greater moisture convergence leads to larger tropical [q] in ERA-40. v) Zonal mean temperature, [T] is 3K cooler in ERA-40 near the tropical tropopause. vi) The zonal mean precipitation, [P] is similar in both datasets, with some exceptions. During DJF, the Atlantic ICZ is largely missing from NDRa2. The intertropical convergence zone (ICZ) over the Atlantic and eastern Pacific is narrower in ERA40 data. The narrower ICZ affects other fields, for example (both TOA and surface) shortwave radiation differences exceed 20% of incoming south of ERA-40s ICZ. NDRa2 has odd vertical motion (and P) extrema over and in JJA. vii) In contrast, the middle latitude [P] is 10-50% less in ERA-40 than in NDRa2. viii) Strong disagreements occur near large-scale higher topography. For example, large standing waves are found adjacent to the southern Andes in ERA-40 vertical velocity. ix) Notable differences occur in polar regions. For example, upper troposphere zonal [T] is 3 K cooler while [u] is upwards of 4 m/s less in ERA-40 over Antarctica.

Keywords: era 40, ncep doe, reanalysis

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JMS020 **Oral Presentation** **1314**

Tropical Shallow Meridional Circulations in Three Global Reanalyses: Agreement, Biases, and Uncertainties

Prof. Chidong Zhang
Meteorology and Physical Oceanography RSMAS, University of Miami IAMAS

David Nolan, Chris Thorncroft

The shallow meridional circulation (SMC) in the tropics is an exciting and intriguing new discovery. It is similar to the Hadley-type deep meridional overturning circulation except its return flow is in the lower troposphere (e.g., 700 hPa). Three global reanalyses (ERA40, NCEP/NCAR, NCEP/DOE) are compared to document biases and uncertainties in their representations of the SMC. Biases are differences between the reanalyses and in situ soundings. When there is no observation for validation, uncertainties are discrepancies among the reanalysis, while their agreement provides the best descriptions available. All reanalyses show SMCs over West Africa, the Atlantic Ocean, the eastern Pacific Oceans, and the Indian subcontinent. The strongest SMC is over West Africa. The strength and seasonal cycle in these SMCs differ substantially among the reanalyses, especially over the open ocean where observations are sparse or unavailable and the reanalysis products rely more on model physics. Comparisons to limited in situ sounding observations show that the SMC in the reanalyses are not artifacts but reproductions of reality. However, the strength and seasonal cycle of the SMC in the reanalyses can differ from those in the soundings. It is proposed that differences in model convective parameterizations and unrealistic diabatic heating profiles they produce may explain the uncertainties and biases of the SMCs in the reanalyses.

Keywords: shallow meriidona circulation, diabtic heating, tropics

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JMS020 **Oral Presentation** **1315**

A Lagrangian Climatology of Stratosphere-Troposphere Exchange derived from the ERA40 data set - its features and the limitations of the underlying data set

Mr. Markus Jonas
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Heini Wernli

A Lagrangian diagnostic for identifying stratosphere-troposphere exchange (STE) is applied to the ERA40 data set and other existing data sets from the ECMWF. In principle, availability of the ERA40 data set offers for the first time the possibility to investigate STE on multi-decadal time periods with relatively high resolutions. The climatologies for mass and ozone STE fluxes show preferred regions of stratosphere-to-troposphere transport (STT) and troposphere-to-stratosphere transport (TST) in the mid-latitudes. This emphasizes the importance of synoptic-scale features versus the mean Brewer-Dobson circulation pattern. As the ongoing debate about stratospheric influence on the troposphere shows, a reliable knowledge of the regions of STE is of great interest for future climate change policies. Furthermore, different ECMWF data sets are used to assess the sensitivity of STE fluxes to the underlying meteorological data set. The experiments show a certain dependence of the integrated mass fluxes to the data assimilation system used (optimum interpolation vs. variational methods) and (less important) the spatial and temporal resolution of the input data. In contrast hereto, the geographical patterns of the fluxes vary much less. Shifts in the assimilated data types, e.g. from the terrestrial based observing system in the earlier parts of the ERA-40 to the current, satellite-dominated earth obeserving system, may hamper a trend analysis and add non-negligible uncertainties to a wide range of tools applied to diagnose fluxes across atmospheric levels. This is shown by analysis of a observation system experiment (OSE) in the late ERA-40 period. An amelioration of this situation will be shown by some selected months of the new, improved "Intermediate ECMWF Re-Analysis".

Keywords: stratosph troposph exchange, ecmwf reanalysis, vertical transport

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JMS020 **Oral Presentation** **1316**

Discrepancy of mass transport between the Northern and Southern Hemispheres among the ERA-40, NCEP/NCAR, NCEP-DOE AMIP-2, and JRA-25 reanalysis

Prof. Jianping Li
LASG, Institute of Atmospheric Physics (IAP) Chinese Academy of Sciences IAMAS

Yufei Zhao

The four reanalysis data, the ERA-40,NCEP/NCAR (NCEP 1), the NCEP-DOE AMIP-2 (NCEP2) and the Japanese 25-year Reanalysis (JRA-25), are comparedfrom differences between re-analyses in very basic, fundamental properties such as the annual cycle of the cross-equatorial mass flux. The atmospheric mass transfer between the Northern Hemisphere (NH) and the Southern Hemisphere (SH) across the equator is calculated from thefour reanalysis datasets and explored for trends which have some notable differences, even contrary phase in the mean annual cycle. The hemispheric and global mean surface pressure anomalies have the coincident trends for the four datasets. The varieties of mass flux and mean surface pressure anomalies are comparatively coincident in ERA-40 and JRA-25 (when the mass flux is northerly (southerly), the mean surface pressure in NH increases (decreases)), but almost contrary verdict in NCEP 1. There's been a notable improvement in NCEP 2 upon NCEP 1, Moreover, NCEP 2 seems likely still not as good as ERA-40 and JRA-25. Furthermore, the research also expands to 60S60N, and the result is similar to that mentioned above.

Keywords: reanlysisdata, atmosphericmasstransport, surfacepressure

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JMS020 **Oral Presentation** **1317**

Climate variability from the new ECWMF ocean reanalysis

Dr. Magdalena Alonso Balmaseda
Seasonal Forecasting ECMWF

David Anderson, Arthur Vidard

A new ocean reanalysis is now available from ECWMF as part of the new operational ocean analysis system (system 3 or S3) at ECMWF. The historical reanalysis starts in 01/01/1959 and is continued up to real time, with a delay of 11 days.The reanalysis is used to provide ocean initial conditions for the seasonal forecasts.The S3 ocean analysis has several innovative features, including an on-line bias correction algorithm, the assimilation of salinity data on T-surfaces and assimilation of altimeter derived sea level anomalies and global trends. A balance between making optimal use of the observation information at the same time as avoiding spurious climate variability in the resulting ocean reanalysis, due to the non-stationary nature of the observing system, are two criteria considered in the design of the assimilation algorithm.It is shown that data assimilation has a large impact on the mean state of the first guess, and consistently reduces the bias and improves the variability. Data assimilation also has a favourable impact on the skill of seasonal forecasts of SST, especially in Western Pacific, where the forecast skill is improved at all lead times. The S3 ocean reanalysis data set is being used for climate variability studies, such as variability in the meridional overturning, attribution of globa sea level trends and recent trends in the ocean heat content.

Keywords: ocean reanalysis, seasonal forecasts, ocean heat content

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JMS020 **Oral Presentation** **1318**

Characteristics and Validation of the NAAPS Aerosol Re-analysis Dataset

Dr. Douglas Westphal
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Jeffrey S. Reid, Cynthia A. Curtis, Timothy F. Hogan, Elizabeth A. Reid, Annette L. Walker, Marcin L. Witek, Piotr J. Flatau

Ten years of global aerosol forecasts from the Navy Aerosol Analysis and Predictions System (NAAPS) have produced a dataset suitable for the study of the climatic significance of aerosol particles. Each day at 00, 06, 12, and 18Z, NAAPS produces six-day forecasts of dust, smoke, sulfate, and sea salt aerosol concentrations for the globe using a bulk microphysical approach. The dynamical forcing data are provide by the Navy Operational Global Atmospheric Prediction System (NOGAPS) weather forecast model. NAAPS has been run in research mode since 1998 and operationally at the Fleet Numerical Meteorological and Oceanographic Center (FNMOC) since 2005. NOGAPS data suitable for input to NAAPS are available beginning in October 1996. From these, a retrospective simulation has been carried out to produce a consistent data set from October 1996 to the present. A systematic validation of NAAPS versus AERONET, MODIS and AVHRR aerosol optical depths (AOT) shows that the model accurately simulates the seasonal patterns and interannual variations. Case studies show that NAAPS captures the timing and transport of individual synoptically driven dust events originating in the Sahara, Asia, and the United States. Numerous authors of peer-reviewed papers have used NAAPS to explain their observational findings or confirm their hypotheses. The daily NAAPS forecast products are used operationally to screen dusty conditions during satellite retrievals of sea surface temperature. The analyses are used for scene generation in satellite algorithm development. The data are also used to support satellite-based lidar retrievals. Atmospheric correction using the data may be possible once a data assimilation capability (under development) is implemented. The characteristics of the dataset and potential applications will be described in the presentation.

Keywords: aerosol, reanalysis, optical depth

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JMS020 **Oral Presentation** **1319**

NASA's Modern Era Retrospective-analysis for Research and Applications

Dr. Michael Bosilovich

Siegfried D. Schubert, Michele Rienecker, Max Suarez, Ron Gelaro, Ricardo Todling

The Global Modeling and Assimilation Office (GMAO) at NASAs Goddard Space Flight Center will begin production of a new global reanalysis. This paper provides an overview of the system and project planning over the last two years, as well as the plans for production and dissemination of the data. Production will be carried out with the Goddard Earth Observing System version 5 (GEOS5) data assimilation system consisting of a global model developed at GSFC, and the GSI analysis system from the National Centers for Environmental Prediction (NCEP). The period of integration covers the satellite era, from 1979-present (we expect to continue into the future, ending no earlier than the end of 2007). The full resolution data will be available on a degree regular grid, but a 2 degree subset will also be available for large-scale applications. The output data streams will include Earth system variables that can be used in a multitude of research and applications problems. In this presentation we will focus on recent results in validating the system, especially in precipitation and water cycle.

Keywords: reanalysis, climate, satellite

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JMS020 **Oral Presentation** **1320**

CTM simulations with assimilated winds: Improvements in the stratospheric circulation

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The use of assimilated winds has been reported to produce unrealistic stratospheric circulation and mixing features when used for long simulations with chemical transport models (CTMs), e.g. a stratospheric age-of-air which is much too young. Such problems limit the ability of the CTMs to calculate realistic tracers distributions. We will show here how some of these problems are being solved with improvements in the assimilation system and the forecast model used to produce the winds. Improvements in the assimilation method itself seem to play a major role in the quality of the winds. This, together with forecast model upgrades and better assimilated observations, produces more realistic assimilated products. In particular we examine here the effects that the improvements in the ECMWF system have had in the representation of the stratospheric transport. We have run the TOMCAT/SLIMCAT off-line 3-D CTM with different assimilation products from the ECMWF: ERA-40 reanalyses (3D-Var), operational analyses 2000 (4D-Var) and several recent reanalysis experiments (3D-Var and enhanced 4D-Var) carried out by the ECMWF in preparation for the production of the next ERA-Interim reanalysis. Trajectory calculations allow us to see how the use of a 4D-Var assimilation technique considerably reduces vertical spurious diffusion, compared to the less sophisticated 3D-Var technique. Also the effect of different lengths of the assimilation window is investigated. The more realistic transport achieved in the tropical region with the new system is further confirmed by tape recorder simulations. The tape recorder signal obtained with the new ECMWF ERA-Interim experiments is in good agreement with observations, and more realistic than that obtained with assimilated winds from previous ECMWF systems (ERA-40 and operational). Age-of-air calculations demonstrate that the improvements consistently extend outside the tropical region. These results are encouraging as they demonstrate the increase in the quality of the stratospheric reanalyses. This will allow more realistic CTMs simulations for examining, for example, long-term trends in chemical composition.

Keywords: stratospheric reanalyses, ctms, multiannual runs

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JMS020 **Oral Presentation** **1321**

A tropospheric assessment of the ERA-40, NCEP, and JRA-25 global reanalyses in the polar regions

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The reliability of the global reanalyses in the polar regions is investigated. The overview stems from an April 2006 Scientific Committee on Antarctic Research (SCAR) workshop on the performance of global reanalyses in high latitudes held at the British Antarctic Survey. Overall, the skill is much higher in the Arctic than the Antarctic, where the reanalyses are only reliable in the summer months prior to the modern satellite era. In the Antarctic, large circulation differences between the reanalyses are found primarily before 1979, when vast quantities of satellite sounding data started to be assimilated. Specifically for ERA-40, this data discontinuity creates a marked jump in Antarctic snow accumulation, especially at high elevations. In the Arctic, the largest differences are related to the reanalyses depiction of clouds and their associated radiation impacts; ERA-40 captures the cloud variability much better than NCEP1 and JRA-25, but the ERA-40 and JRA-25 clouds are too optically thin for shortwave radiation. To further contrast the reanalyses skill, cyclone tracking results are presented. In the Southern Hemisphere, cyclonic activity is markedly different between the reanalyses, where there are few matched cyclones prior to 1979. In comparison, only some of the weaker cyclones are not matched in the Northern Hemisphere from 1958-2001, again indicating the superior skill in this hemisphere.Although this presentation focuses on deficiencies in the reanalyses, it is important to note that they are a powerful tool for climate studies in both polar regions when used with a recognition of their limitations.

Keywords: reanalyses, antarctic, arctic

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JMS020 **Poster presentation** **1322**

Satellite Assessment of Water Vapor Transport from NCEP, ERA40, and JRA25 Reanalyses over the Asian Summer Monsoon Region

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Byung-Ju Sohn, Bin Wang

The divergent component of water vapor transports was constructed using evaporation, precipitation, and total precipitable water estimated from the Special Sensor Microwave Imager (SSM/I). The SSM/I moisture budget parameters are then compared with those from the National Centers for Environmental Prediction (NCEP), the European Centre for Medium-Range Weather Forecasts (ECMWF) 40-year Reanalysis (ERA40), and Japanese 25-year Reanalysis Project (JRA25) data over the Asian monsoon region for the May to September (MJJAS) period from 1988 to 2000. The long-term summer mean climatology of SSM/I water vapor transports clearly indicates three major water vapor sources for the Asian monsoon, i.e., the subtropical Indian Ocean and Pacific Ocean in the Southern Hemisphere, and the North Pacific Ocean. In contrast sinks are located in the Asian summer monsoon tough, the equatorial convective zones over the Indian and western Pacific oceans, and over the East Asian monsoon region from the northern tip of Philippine Sea to the Kuroshio extension region. These sources and sinks are linked to well-known large-scale rotational circulation features, i.e., the low-level cross-equatorial flow associated with the Somali jet, the anticyclonic circulation along the western periphery of the western North Pacific High, and the cross-equatorial flow north of New Guinea. In conjunction with the fluctuation of these sinks and sources, the northward propagating climatological intraseasonal oscillations in water vapor flux convergence are evident in the South and East Asian monsoon regions in the SSM/I data. From the comparison of water budget parameters of NCEP, ERA40, and JRA25 reanalysis with SSM/I-derived features, we found that the general features of all three reanalyses are in good agreement with those from SSM/I; however, the magnitudes of water vapor transports are considerably weaker in all three reanalyses. In addition, much weaker water vapor transports in three reanalyses are found in the intraseasonal oscillation signals although the oscillation patterns are quite similar to what inferred from the SSM/I measurements.

Keywords: satellite, reanalyses, monsoon

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JMS020 **Poster presentation** **1323**

Investigation of circulation indices

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A basic indices can be derived from temporal means of different fields of ERA-40 database. For each grid points or regions trends can be analysed, which have essential information of cyclonal and anticyclonal field for decades or for the whole 50-year-period. It is useful to examine the change in the circulation of the exact region. The zonality index, which can be derived from meridional MSL pressure gradient (like NAO index) between chosen latitudes has information about the circulation of the European continent. This can be calculated between 2 grids at the same longitude. Another way is to determine the average of the parameter at two given latitudes and calculate their difference. Last, but not least the temporal change in meridional temperature gradient shows the difference of this elementary parameter between 2 grids at the same latitude, which is important in cyclone development. These indices can be derived from ERA40 database for 6-hour-temporal resolution, and the connection with regional, measured and homogenized database can be examined. Regional circulation can be researched through smaller weather systems. In the Carpathian region changes in meteorological parameters (for example meteorological fronts and its frequency) should be detected in an objective way. Results can be used for many purposes.

Keywords: era 40, circulationidices

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JMS020 **Poster presentation** **1324**

Mid-latitude Atmospheric Variability of the NCEP-NCAR and ECMWF Reanalyses

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We compare 45 years of the reanalyses of NCEP-NCAR and ECMWF in terms of their representation of the mid-latitude winter atmospheric variability for the overlapping time frame 1957-2002. We adopt the classical approach of computing the Hayashi spectra of the 500hPa geopotential height fields and we introduce an ad hoc integral measure of the winter variability observed in the Northern and Southern Hemisphere on different spectral sub-domains. In the Northern hemisphere discrepancies are found especially in the pre-satellite years of the records in the high frequency-high wavenumber propagating waves. This implies that in the pre-satellite period the two datasets have a different representation of the baroclinic available energy conversion processes. Minor differences are also found in the description of low frequency-low wavenumber standing waves. We observe a positive impact of the satellite data on the representation of wave activity over the oceanic sectors in the period starting from 1979, in particular on the description of high frequency variability. In the Southern Hemisphere we find important discrepancies in the description of the atmospheric waves at different spatial and temporal scales. ERA40 is generally characterized by a larger variance, especially in the high frequency spectral region. Compared to the northern hemisphere, the assimilated data are relatively scarce particularly over the oceans, and they provide a weak constraint to the assimilation system even in the period when satellite data is available. In the pre-satellite period the discrepancies between the two reanalyses are large and randomly distributed; after 1979 the discrepancies are systematic.

Keywords: wave activity, low frequency, high frequency

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JMS020 **Poster presentation** **1325**

Comparison of Surface Turbulent Flux Products

Mr. Paul Hughes

Mark A. Bourassa, Jeremy Rolph, Shawn R. Smith

Surface turbulent fluxes (stress, sensible heat, and latent heat) are compared for many products. Data sets based on weather models include the NCEPR, ECMWF (operational and reanalysis), and JRA. Data sets based on in situ observations include NOCS (formerly SOC) and FSU3. Purely satellite products include those from IFREMER and HOAPS. A hybrid NWP model and satellite product from WHOI is also included in this comparison. Sea surface temperatures, winds, and stresses are well sampled (on a monthly scale) from satellites, and can be used as a standard of comparison. There are no similar satellite-based standards for heat and moisture fluxes, nor for atmospheric temperatures and humidity, which are closely related to these fluxes. The atmospheric temperatures and humidities in the NOC and FSU3 flux products have been developed with detailed bias correction (suggesting that they could be viable standards of comparison), and are relatively similar; however, there are still substantial differences in these products. We identify relative strengths and weaknesses of these products, including characterizations of their differences.There are very large differences in estimates of stresses and heat fluxes. The reanalyses based on numerical weather prediction (NWP) stand out as outliers from the observation-based products. For the Atlantic and Indian Ocean basins, the various products have differences in zonally averaged latent heat fluxes of 30 to 50 Wm-2, and zonally averaged differences of sensible heat of 5 to 10 Wm-2. These differences are large from the point of view of climate modeling. Monthly averaged satellite winds (from QuikSCAT and SSM/I) are extremely similar to the FSU3 and NOCS winds.In general, differences in fluxes are either due to the choice of flux model or biases in the input data to the flux model. The input data are also examined to identify biases that would lead to biases in the fluxes. The large differences in modeled stresses and heat fluxes are discussed, and the credibility of NWP-based air/sea fluxes are assessed. The presumed NWP biases are substantial in the context of global change, as they appear to be strong enough to have a large influence on model temperatures in long-term model runs.

Keywords: turbulent, flux, products

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JMS020 **Poster presentation** **1326**

A comparison of latent heat fluxes over global oceans for ERA and NCEP with GSSTF2

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Licheng Feng

The ECMWF Re-Analysis (ERA) and NCEP reanalysis monthly latent heat flux (LHF) data are compared with those of the Goddard Satellite-Based Surface Turbulent Fluxes, version2 (GSSTF2), respectively, during the period of 19882000, over the global oceans between 60S and 60N. Qualitatively, the annual mean LHF fields and monthly variations are similar for GSSTF2, ERA, and NCEP. Quantitatively, however, there are distinct differences among them. The annual mean ERA LHF is closer to GSSTF2 than NCEP in the tropics (525S and 822N) and midlatitudes, while the situation is opposite in other zones. The temporal variability of monthly LHF difference (ERA-GSSTF2) is smaller than that of NCEP-GSSTF2 in and Qs-a.

Keywords: latent heat fluxes, reanalysis

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JMS020 **Poster presentation** **1327**

Interannual and interdecadal variations of temperature and precipitation in Bulgaria estimated from high-resolution climate data sets

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Nikolay Rachev

Nowadays the high resolution re-analysis data sets are widely used in estimation of climate variability and validation of climate models simulations. This requires that their reliability is carefully checked through comparison with independent data. In the present study the CRU climatological data for surface temperature and precipitation (0.5x0.5 degree in longitude and latitude directions) are compared with data from 135 stations for the area of Bulgaria and period 1961-1990. The purpose is to check their ability to represent the main climatic characteristics in regard to the above mentioned period for a region with divers landscape and climate conditions. Then the interannual variability of the temperature and precipitation for the period 1901-2000 is investigated and the main frequencies in the spectrum are identified.

Keywords: climatology, interannual, variability

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JMS020 **Poster presentation** **1328**

Reconstruction of the ENIAC Forecasts using the NCEP-NCAR Reranalysis

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The ENIAC forecasts in 1950 paved the way for the remarkable advances made over the past half century in weather prediction and climate modeling. We review the circumstances in which the forecasts were made, the nature of the ENIAC computer and the role of the key players. The basis for the forecasts was the barotropic vorticity equation, and the initial data were prepared manually from standard weather charts. Now that the NCEP--NCAR reanalysis extends back to 1948, the initial height fields for the forecasts are readily available in digital form. We describe the reconstruction of the forecasts and compare the results to the original integrations. Objective scores show shows that they all has some predictive skill and, with a minor modification, might have been still better. We provide a quantitative answer to the question 'Were the forecasts any good?'

Keywords: eniac, nwp, reanalysis

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JMS020 **Poster presentation** **1329**

Intercomparison of NCEP Reanalysis and Drifting Stations North Pole Data in Application to the Thermodynamic Sea Ice Model

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Andrey Proshutinski, Mikhail Kulakov, Sergey Shutilin

The results of intercomparison of all available meteorological data, obtained on the drifting stations North Pole 3 - 34 in 1954 2006 years, with interpolated to the same positions data of NCEP reanalysis for periods 1954 1978 (before satellite era), 1978 1991 (satellite information had been included in NCEP), and 2003 2006 (recent weather conditions) are shown.The good agreement between data for surface pressure (correlation above 0.99, mean difference below 1hPa), and module, zonal, and meridian components of surface wind velocity (correlation 0.8 0.9, mean difference about 1 m/s) in both archives are revealed.The results of comparison of surface air temperature are more worse, except winter, when correlation exceed 0.83 and mean difference about 0.10C. In spring and autumn under correlation above 0.9, determined by well-pronounced seasonal changes, the differences in NCEP and NP temperatures exceed +50C in spring and -50C in autumn. Summer, season with rather stable and closed to melt point surface air temperature, is characterized by the lowest correlation 0.55 and highest in relation to mean square deviation mean difference (1.2 0C).Comparison the data about specific humidity shows similar results: the significant overestimations by NCEP of specific humidity during summer, when its values are maximal and renders strong influence on sea ice surface heat balance.Our analysis confirms well-known information that reproducing of cloudiness by NCEP reanalysis is quite inadequate, especially in summer. Same times in winter under sliding averaging by 5 days the distributions of repeatability of cloudiness (in tenth) are very close each other. This circumstance allows recommending to use sliding averaged cloudiness from NCEP for winter instead climatic values, usually used in climatic sea ice models.Comparison of both datasets for three periods does not show any significant improvements after beginning of satellite era.In conclusion the results of some numerical experiments with zero-dimensional sea ice model under NCEP and NP forcing revealing that negative feedbacks existing in nature and reproduced by model artificially reduce the influence of inaccuracy of forcing parameters on calculating sea ice thickness, but distort values of surface heat fluxes.

Keywords: ncep reanalysis, intercomparison, data

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JMS021 **1330 - 1355**

Symposium
Energetic Particles and Geomagnetic Storm Influence on Chemical and Dynamical Processes in the Polar Stratosphere and Mesosphere

Convener : Dr. Cora Randall, Dr. Yvan Orsolini, Dr. Alexei Krivolutsky

This symposium covers satellite and ground based observations, numerical simulations and theoretical studies of the polar stratosphere and mesosphere response to solar protons and precipitating electrons penetrating into the polar atmosphere during solar proton events, and periods of geomagnetic storms. Studies devoted to perturbations in the D-region after external forcing from above, and comparison with changes in neutral composition, are also welcome

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JMS021 **Oral Presentation** **1330**

Peculiarities of long-term trends of lower atmosphere temperature in Antarctica and their possible connection with outer belt electron precipitation

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Both experimental and model studies of long-term climate changes above the Antarctica continent indicate presence of a strong climate warming at the region around the Antarctic Peninsula including the Weddell Sea area, which differs significantly from the climate tendency in other parts of Antarctica. This warming is the most intense on the Earth together with similar regions of warming located in Alaska and in North-East Siberia. Another demonstration of this warming is a permanent presence of so called polynya (a great spot of unfrozen open water) in the Weddell Sea. Up to now all attempts to explain these unusual natural phenomena by the traditional meteorological factors turned out to be inadequate. It is shown in this paper that the region of intense global warming around Antarctic Peninsula as well as area of the Weddell Sea polynya precisely coincide with a stable maximum of energetic electron precipitation (E > 1 MeV) from the Earth radiation belt. Depth of penetration of these particles into atmosphere could be as low as 20-40 km. Penetrating fluxes of these energetic electrons significantly change dynamical and photochemical processes in the middle atmosphere. Energetic resources of this phenomenon are quite sufficient in order to supply input of thermal energy capable to warm atmosphere in this region. Possible sequence of the relevant physical processes is considered in this report. Further study of interaction between the auroral and mid-latitude atmospheres during geomagnetic storms and superstorms is an important part of the solar-terrestrial physics. There are a lot of things to be done in this direction.

Keywords: geomagneticstorms, middleatmosphere, energeticelectrons

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JMS021 **Oral Presentation** **1331**

Effect of solar activity on atmospheric processes in the southern polar region

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Fluxes of galactic cosmic rays altered by solar wind and spikes of solar cosmic rays are usually examined as one possible mechanism of solar activity influencing the Earths atmosphere. The detail analysis of the meteorological data from Antarctic stations Vostok and Dome C made it possible to conclude that dramatic changes of the troposphere temperature, observed in the Central Antarctica, are related to the interplanetary shocks, accompanying Forbush decreases (FD) and solar protons events (SPE). The temperature effects on the ground level are caused by quick change of the interplanetary magnetic field (IMF) and corresponding variations of the geoeffective electric field (ESW) carrying by the solar wind. The warming is observed at altitudes h<5 km and cooling at h>8 km, when the changes in the IMF BZ component are negative and ESW increases. The effect reaches maximum within one day and is damped equally quickly. The availability of the katabatic type of atmospheric circulation in the southern near-pole region and opposite character of the altitude dependence for the temperature, pressure and wind speed deviations in cases of the negative and positive ESW makes it possible to suggest that the geoeffective electric field ESW promotes, through the global electric circuit, the appearance and development the cloud layer in the upper troposphere. The cloud layer would efficiently backscatter the long wavelength radiation going from the ice sheet, but it will not affect the adiabatic warming process. As a result of the radiative cooling reduction the atmosphere would be heat below the cloud layer and would be cool above the layer, as it was observed. Indeed, analysis of the aerological observations at Vostok station demonstrated the cloudness increase above the station under conditions of the negative IMF Bz. The troposphere warming in the Central Antarctica is followed within few days by the reconstruction of the wind pattern above the entire southern polar region. The dramatic deviation of atmospheric winds from the regular pattern (anomalous winds) at the Antarctic continental and coast stations, succeeding strong southward IMF, leads to decay of the circumpolar vortex at about the periphery of the Antarctic continent. As a result, the surface easterlies at the coast stations are replaced by southerlies, and the cold air masses rush from Antarctica to the Southern Ocean. Mechanism for influence of the global electric circuit on the cloud layer properties is unclear and needs in further consideration.

Keywords: interplanetary, electric, field

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JMS021 **Oral Presentation** **1332**

High latitudinal variations of aerosol optical properties under solar forcing

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Dmitri Ponyavin

Highest latitudes are the regions where precipitations of energetic particles of solar and galactic origins into the Earths atmosphere are more probabilistic. For this reason under founding solar signal in optical parameters of atmosphere it is very important to pay a special attention to Polar Regions. Here we present a systematic statistical study of a relation between the observed short-term (some days) variations of atmospheric aerosol optical depth at high latitudes and cosmic rays of solar and galactic origin for the period 1976-2005. It is taking into account solar proton events, ground level effects of solar protons and Forbush decreases of galactic cosmic rays. As parameter characterizing aerosol optical depth of atmosphere were chosen TOMS aerosol index. The TOMS (Total Ozone Mapping Spectrometer at NASA spacecraft) aerosol index is related to aerosol optical depth, which, in turn, indicates how much light is scattered or absorbed by particles while passing through a column of the atmosphere. As a summary of the results we conclude that the solar activity can be an additional factor which affects the variations of the optical properties of aerosols. Finally, the reaction of atmospheric aerosol on solar activity changes is discussed.

Keywords: cosmic rays, aerosol optical depth, high latitudes

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JMS021 **Oral Presentation** **1333**

Downward transport of EEP produced NOx from mesosphere/lower thermosphere and its impact on the stratosphere NOy and ozone budget

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Thomas Von Clarmann, Thomas Reddmann, Herbert Fischer, Bernd Funke, Manuel Lopez-Puertas, Miriam Sinnhuber

NOx production in the mesosphere and lower thermosphere (MLT) due to EEPs, its subsequent downward transport within polar winter vortices, and its impact on stratospheric NOy and ozone chemistry is currently in the focus of interest. Various publications suggest a link between solar activity and the MLT NOx production, as well as a link and/or possible feedback between man-made climate change and downward transport mechanisms. An overview on the contributions from the MIPAS/ENVISAT observations to this topic, combined with data from other instruments and 2D- and 3D-CTM studies, will be presented. Enhanced levels of NOx in the upper stratosphere and lower mesosphere have been found for several winters within polar vortices. NOx was subsequently transformed to other NOy species, leading, for example, to a secondary upper stratospheric HNO3 maximum. The impact of upper stratospheric enhanced NOx levels, the mechanisms of their transformation to other NOy species, and their effect on the stratospheric ozone budget has been studied with chemical models including ion cluster chemistry. Model results show that resulting stratospheric ozone losses in polar regions can reach 20 DU, and last for month to years.

Keywords: eep, nox, mipas

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JMS021 **Oral Presentation** **1334**

Middle Atmospheric Production of HOx and NOx by Solar Protons: A Solar Cycle 23 Update

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Solar cycle 23 was particularly active with several very large solar proton events (SPEs). Solar protons caused atmospheric ionization and dissociation, which led to the production of HOx (H, OH, HO2) and NOx (N, NO, NO2). Satellite instruments recorded enhancements in HOx and NOx in the years 2000-2005 due to SPEs. The Aura MLS instrument observed substantial mesospheric increases in OH during the very large SPEs in January 2005, the first direct confirmation of OH production by solar protons. Other satellite instruments measured huge NOx enhancements in the middle atmosphere due to other certain very large events. For example: a) UARS HALOE and POAM III observed NOx increases after the very large July 2000 SPE; and b) UARS HALOE, Envisat MIPAS, and Envisat GOMOS measured NOx increases after the very large October-November 2003 SPEs. These SPE-caused HOx and NOx enhancements are important because they ultimately lead to ozone destruction. Observations of the HOx and NOx enhancements due to SPEs will be discussed and compared with predictions by atmospheric models of these constituents.

Keywords: middle atmosphere, hox nox, solar proton event

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JMS021 **Oral Presentation** **1335**

Interaction between atmospheric chemical composition, temperature and dynamics during solar proton events

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Grigory Zakharov, Tatyana Vyushkova, Alexander Kuminov, Anna Kukoleva, Irina Maygkova

Solar energetic particles, which penetrate into the atmosphere of the Earth at high latitudes, cause its ionization. It leads to the additional production of nitrogen and hydrogen oxides in the middle atmosphere. Each pair of produced ions born 1.25 molecular of NO and 2.0 molecular of OH, which destroy ozone in chemical cycles. This conception was used in order to investigate the response of the atmosphere to major SPEs of 23-rd cycle of solar activity. Middle atmosphere GCM (COMMA/CAO) and 3D transport photochemical model has been used for such study. Changes in ozone structure during and after SPEs has been incorporated into radiative module of GCM for each SPE disturbing temperature fields and circulation. The results of simulations showed that selected major SPEs caused strong depletion in ozone at high latitudes. However, SPE of July 2000 induced weak ozone response over south polar region (polar night conditions). Practically zero response in temperature and dynamics was found over S.P. for this SPE. It was found also that SPE-induced changes in zonal wind change (reduce) the magnitude of gravity wave drag reducing cooling of the mesosphere over summer pole (northern) during SPE of July 2000. This effect was weaker for SPEs occurred in other seasons. So, 3D model simulations illustrate the effects of interaction between chemistry and dynamics in the atmosphere during strong SPEs.

Keywords: protons, ozone, 3d modeling

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JMS021 **Oral Presentation** **1336**

Charge energetic particles at low alitude polar orbits during 2001-2006 years: russian space missions measurements.

Dr. Irina Myagkova
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Charged energetic particles produced in solar flares and accelerated in solar atmosphere or/and in interplanetary space strongly influence on dynamical and chemical processes in the polar stratosphere and mesosphere. Solar protons and electrons penetrate in the polar caps due to the open magnetic field lines, and SPEs mostly cause chemical changes in both polar regions. So, it leads to the possibility for solar particles after SPEs cause global effects in the composition of the atmosphere. Satellites with low altitude polar orbits allow one to measure both solar energetic particle dynamics and variations of the solar particle penetration boundaries. The solar particle penetration boundaries measurements are especially important during periods of geomagnetic storms, when the significant variations of polar caps sizes are observed. Two Russian space missions were launched at low altitude polar orbits during the second half of the last solar activity cycle (2001- 2006 yy) - CORONAS-F and "Universitetskiy-Tatiana" satellites. One of the main goals of the Russian solar observatory CORONAS-F (Complex ORbital Observations in the Near-Earth space of the Activity of the Sun) was the study of SEP events influence on the near-Earth's environment. CORONAS-F was launched to the orbit with the inclination 82.5 degrees, initial altitude about 500 km and final one 350 km, on July 31, 2001 and was operated until December 12, 2005. Its orbital period of 94.8 minutes corresponds to about 15 circuits per day. Charged particles in different energy ranges (protons with energy 1-90 MeV, electrons 0.3-12 MeV) were measured by semiconductor and plastic scintillator detectors. "Universitetskiy-Tatiana" satellite was launched to the orbit with the inclination 83 degrees, initial altitude about 1000 km on January 20, 2005 (during one of the most powerful SEP event of 2005) and operates until now. It was carried out in the frame of Space Scientific and Education project of Lomonosov Moscow State University "MSU-250", which was timed to its 250-th anniversary. The scientific task of this project is the monitoring of radiation conditions near the Earth. In this work we used data on protons with energies 2-100 MeV and electrons with energies 0.07-0.9 MeV, obtained by semiconductor detector and scintillation detector. Long-time monitoring both solar energetic particle dynamics and its penetration boundaries by CORONAS-F and "Universitetskiy-Tatiana" has an opportunity for the modelling of long-term effect in ozone layer of the Earth. This work has been partly supported by grant N 06-05-64436-a of the Russian Foundation for Basic Research.

Keywords: flares, sep, ozone

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JMS021 **Oral Presentation** **1337**

Nox enhancements in the middle atmosphere: the relative significance of solar proton events and the aurora as a source

Mrs. Annika Seppala
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Mark A. Clilverd, Craig J. Rodger

In this study we combine odd nitrogen (NOx) observations from the satellite instruments with a radio wave ionisation index to provide a detailed description of the generation and descent of polar NOx into the upper stratosphere during the Northern Hemisphere winter of 2003-2004. The measurements are used to study the relative contributions of ionization due to solar proton events, energetic electron precipitation, and auroral precipitation on NOx production, and its subsequent downward transport to the upper stratosphere. We show that NOx generated from the large solar proton storm in October/November 2003 was transported into the upper stratosphere in agreement with model calculations, but that aurorally generated NOx also descended later in the winter. Both periods were highly significant and produced large long-lived decreases in stratospheric ozone. The observations made by GOMOS/Envisat deep into the nighttime polar vortex prove critical in differentiating between the stratospheric effects of these two events.

Keywords: odd nitrogen, particleprecipitation, ozone

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JMS021 **Oral Presentation** **1338**

Arctic and Antarctic polar winter nox and energetic particle precipitation in 2002-2006

Mrs. Annika Seppala
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Pekka T. Verronen, Mark A. Clilverd, Cora E. Randall, Johanna Tamminen, Viktoria Sofieva, Leif Backman, Erkki Kyrl

We report GOMOS nighttime observations of middle atmosphere NO2 and O3 profiles during eight recent polar winters in the Arctic and Antarctic. The NO2 measurements are used to study the effects of energetic particle precipitation and further downward transport of polar NOx. During seven of the eight observed winters NOx enhancements occur in good correlation with levels of enhanced high-energy particle precipitation and/or geomagnetic activity as indicated by the Ap index. We find a nearly linear relationship between the average winter time Ap index and upper stratospheric polar winter NO2 column in both hemispheres. In the Arctic winter 2005-2006 the NOx enhancement is higher than expected from the geomagnetic conditions, indicating the importance of changing meteorological conditions.

Keywords: odd nitrogen, energetic particle precipitati, gomos

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JMS021 **Oral Presentation** **1339**

Temporal variability of the descent of high-altitude nox inferred from ionospheric data

Dr. Mark Clilverd
IAMAS

Annika Seppl, Craig J. Rodger, Neil R. Thomson, Jnos Lichtenberger, Pter Steinbach

We investigate periods of enhanced ionization in the mesosphere during northern hemisphere winter-times. Long-lasting ionization enhancements (days) are typically produced by solar proton events, or by the descent of thermospheric NOX during periods of sustained downwards vertical transport associated with a strong underlying polar vortex. Using a new application of ground-based low frequency radio wave remote sensing we study the mesospheric ionization conditions during the northern hemisphere winters spanning 2003-04, 2004-05, and 2005-06. The winter 2003-04 subionospheric radio wave propagation data from a transmitter in Iceland shows signatures of the descent of NOX through 80km altitude starting on January 13, 2004, during the occurrence of a strong polar vortex, indicating a thermospheric source for the NOX. Similar analysis of radio wave propagation data in the northern hemisphere winter of 2004-05 does not show a NOX descent event passing through the mesosphere, due to a lack of downward vertical transport as a result of a weak underlying polar vortex, despite the occurrence of significant solar proton ionization during January 2005. In 2005-06 there were no significant ionization events and also no descent of significant amounts of thermospheric NOX, despite a strong polar vortex and strong vertical transport. We model the signature of the descent of NOX seen in the radio wave propagation data using the Sodankyl Ion Chemistry model, confirming that the levels of NOX in the mesosphere are ~100 times the usual background levels. The combination of strong NOX sources in the thermosphere and also a strong polar vortex is required for NOX to descend into the stratosphere with significant concentration levels.

Keywords: particle precipitation, nitric oxide, polar vortex

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JMS021 **Oral Presentation** **1340**

Chemical and dynamical response of the middle atmosphere to solar proton events

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IAMAS

D.E. Kinnison, F.M. Vitt, R.R. Garcia, C.H. Jackman

During the declining phase of solar cycle 23, ionization from energetic particle precipitation in the polar regions during several large solar proton events (SPEs) lead to significant increases in the concentration of hydrogen and nitrogen species. These changes affected stratospheric and mesospheric ozone concentrations and temperatures. This study uses NCAR's Whole Atmosphere Community Climate Model (WACCM) to examine the chemical and dynamical response of the middle atmosphere to this series of SPEs. WACCM is a general circulation model that incorporates interactive chemistry that solves for both neutral and ion species. Analysis of an ensemble of WACCM simulations indicates that SPEs affect ozone chemistry either directly via increased catalytic loss, or indirectly from perturbations to active chlorine and bromine partitioning. In the stratosphere, ozone and temperatures changes can persist for months following an SPE and are not restricted to the region where SPE ionization occurred.

Keywords: spe, waccm, solar proton event

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JMS021 **Oral Presentation** **1341**

N2O as a possible marker of high energy auroral precipitation

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The ACE instrument on SCISAT-I observed very high values of NOx and N2O in the lower polar mesosphere in February of 2004. Recently analysed GOMOS data have revealed high polar NO2 values during the same period.Anomalous N2O values in the mesosphere have also been seen by ACE in other years. Using the CMAM chemistry climate model, we examine whether the N2O production is driven by NOx transport from above or in situ production of N and NO by high energy electron ionization. Preliminary results suggest thatN produced by ionization is essentialfor the production of N2O and, given the short lifetime of N, that N2O is producedlocally where NO2 is present below around 80 km.The ionization rate is inferred from observations of electron fluxes and energies by the MEPED instruments on NOAA polar orbiting environmental satellites.

Keywords: aurora, chemistry, mesosphere

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JMS021 **Oral Presentation** **1342**

Response of the lower ionosphere to solar proton event on July 14 2000. Model simulations over the both poles

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One of the strongest Solar Proton Events (SPE) of the 23rd solar cycleoccured on 14 July 2000. Excess ionization by solar protons at altitudes 50-90 km caused enhanced absorption of cosmic HF radio waves. Absorptions up to 15 dB were detected e.g. by the Finnish riometers during the main phase of the event. Response of the mesosphere and especially of electron and ion concentrations in the lowerionosphere to this SPE is studied with the emphasis on the differenceover the North and South Pole. General circulation model and 3D chemical global transport-photochemical middle atmosphere model are used for simulations of neutral composition, wind and temperature response. Using these results, concentrations of the short-living ions in the lower ionosphere are calculated by 1D photochemical model of the lower ionosphere. SPE-induced ionization rates in the polar atmosphere are calculated using high time-resolution satellite measurements of solar proton fluxes provided by GOES-10. Our simulations show that electron concentrations over the both polesincrease by more than 3 orders of magnitude. In the nothern polar region(in polar summer) this enhancement lasts longer than in the southern polarregion (in polar night). Significant temperature changes in northern polarmesosphere during the SPE found by Krivolutsky et al. (2006) contribute to the electron concentration changes by 10 % at 88-98 km on day 5 to 8 after the SPE onset. Present simulations show greater SPEresponse of negative ions over the sun-lit northen polar cap then in thedark souther polar ionosphere. Response of the positive clusters is foundsimilar in the both hemispheres. Cluster ion to molecular ion ratio is foundto decrease by 2 orders of magnitude over the both poles, which is inagreement with measurements preformed during the November 1969 SPE.

Keywords: solar proton event, lower ionosphere, ion composition

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JMS021 **Oral Presentation** **1343**

Thermospheric nitric oxide at higher latitudes Model calculations with auroral energy input

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The nitric oxide (NO) density in the lower thermosphere has been calculated by a photochemical model for NOx and compared with measured NO densities. At higher latitudes the most important contributor for NO density increases is energetic electron precipitation. The electron energy input is divided into geographic areas of 5o latitude and 24o longitude for a continuous time interval of four days. The energy is estimated in two ways; from auroral ultraviolet (UV) and X-ray measurements, and from ground magnetometer measurements. These are used as input for the photochemical NOx model. The UV and X-ray measurements are from the Ultraviolet Imager (UVI) and the Polar Ionospheric X-ray Imaging Experiment (PIXIE), both on the Polar spacecraft. For the time intervals without UVI and PIXIE measurements, a parametrization of the electron energy flux from ground magnetic measurements was used. This parametrization was based on data from the SuperMAG database compared to UVI/PIXIE derived electron energy fluxes. The negative perturbation in the northward ground magnetic component is found to be linearly related to the precipitating electron energy flux derived from UVI and PIXIE measurements. The four day period studied is from 30 April until 4 May 1998, where the onset of a geomagnetic storm occurred 2 May (day 122). The modelled NO density is compared with NO measurements from the Student Nitric Oxide Explorer (SNOE). The results show an overall larger modelled nitric oxide density at auroral latitudes than what was measured by SNOE. The largest discrepancies were for the day of the storm onset, when the background atmosphere was most distorted by Joule heating. The next day, when the atmosphere had settled down, the agreement between the model and the observations was far better.

Keywords: electron precipitation, nitric oxide density, modeling

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JMS021 **Oral Presentation** **1344**

Regional Response of the Mesosphere-Lower Thermosphere Dynamics over Scandinavia to solar proton events and geomagnetic storms in late October 2003

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Werner Singer, Plamen Mukhtarov

The short-term regional responses of the mesosphere-lower thermosphere (MLT) dynamics over Scandinavia to the exceptionally strong solar storms with their accompanying solar proton fluxes on the Earth in late October 2003 have been investigated using radar measurements at Andenes (69oN, 16oE) and Esrange (68oN, 21oE). Several solar activity storms resulted in solar proton events (SPEs) at this time but particularly active period of high proton fluxes occurred on 28-31 October 2003. The significant temperature drop (~25 K) has been detected by the meteor radar at Andenes at altitude ~90 km, which is in line with the enhancement of the proton fluxes and caused by the dramatic reduction of the ozone in the high-latitude middle atmosphere monitored by satellite measurements as well as in consequence of dynamical changes due to particle heating in the mesosphere. This exceptionally strong phenomenon in late October 2003 was composed of three geomagnetic storms, with the first one occurring in the day time of 29 October and the other two storms at night time of 29 and 30 October respectively. The responses of the prevailing wind and the main tides (24- and 12-h tides) have been studied in detail. It is found that the response of the MLT dynamics to the first geomagnetic storm occurring in the day time and accompanied by solar proton fluxes is very different from those to the second and third geomagnetic storms with onsets during the night-time. This case study revealed the impact of the solar proton events (SPEs) observed in late October 2003 and the timing of the geomagnetic storms on the MLT neutral wind responses observed over Scandinavia .

Keywords: solar proton events, geomagnetic storms, mlr dynamics

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JMS021 **Oral Presentation** **1345**

Strong NO2 enhacements in the high latitude middle atmosphere in winter as seen form GOMOS/ENVISAT

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Strong enhancements of NO2 are often observed by GOMOS/ENVISAT instrument in winter at high latitude in both hemispheres. Some cases are clearly related to the production of NOx by energetic particle precipitations as for instance during the strong solar proton event in late October-November 2003. In some other cases, i.e. in January 2004, there is no noticeable particle precipitation and the NO2 enhancement is attributed to a rapid descent of air rich in NO from the upper mesosphere/lower thermosphere. This explanation is supported by the observation of a strong temperature increase around 70 km at the time of NO2 enhancement, indicating a strong adiabatic warming related to descent of air. The two processes will be presented and the implication for NOx and O3 budgets in the polar middle atmosphere will be discussed.

Keywords: no2, mesosphere, stratosphere

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JMS021 **Oral Presentation** **1346**

Upper stratospheric nitric acid polar enhancements observed by the ODIN satellite in 2001-2007

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High altitude enhancements in nitric acid are recurrently seen in the polar, upper stratosphere in winter, in both hemispheres. but with considerable inter-annual variability. They have been linked to fluxes of NOx from the mesosphere or to in-situ NOx formation by energetic particle precipitation. Through slow descent in the winter polar vortex, they can influence the lower stratospheric composition. The strong enhancements following the exceptional solar storms of the autumn 2003 have been well documented. We examine observations of nitric acid by the ODIN satellite over the years 2001-2007, to examine the factors governing the formation of these high-altitude enhancements, and in particular the role of solar proton events, or other energetic particle precipitation, and of rapid mesospheric descent.

Keywords: stratosphere, solar, energetic particle

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JMS021 **Oral Presentation** **1347**

Solar and interplanetary origin of the unusual atmospheric circulation conditions on the Pacific Southern hemisphere Magnetic Anomaly region during intense magnetic storms

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Evidences of the solar activity modulation of the Earths climate have been observed on decadal to millennial scales. The main climate forcing proposed to explain these observations are: (1) the variability of the total solar irradiance; (2) the variability of the solar ultraviolet emission and its effects on the stratospheric ozone and thermal structure; (3) the cosmic rays effects on the cloud coverage; and (4) high energy particle precipitation effects on mesospheric and stratospheric ozone in the auroral and/or southern hemisphere magnetic anomaly regions during solar storm events. It is conceivable that these mechanisms contribute to varying extends on different regions. However, the precise roles of each process during extreme solar events have not yet been investigated. Here we show that the unusual atmospheric circulation conditions over the southern Pacific and Atlantic oceans, and South America during the occurrence of intense magnetic storms could be related to the energy deposition on the upper atmosphere of the auroral and/or southern hemisphere magnetic anomaly. We analyzed solar, interplanetary, magnetospheric, ionospheric and atmospheric parameters observed during intense geomagnetic storms. We observed changes in the position and intensity of the Intertropical Convergence Zone and in the South Pacific Convergence zone. It was also observed the occurrence of fast cold fronts over the South America. Changes on several atmospheric parameters were observed in the south Pacific high pressure center. These changes are related to the development of anti-cyclones in the South Pacific after the onset of the magnetic storm events events. We observed also changes in the position and intensity of the Intertropical Convergence Zone and in the South Pacific Convergence zone. This result reveals that effects on the atmospheric conditions, including cloud coverage and radiative flux in the atmosphere, in the southern hemisphere magnetic anomaly region could be observed during extreme solar conditions. Previous studies suggested that the influence of solar activity on climate could be observed on decadal to millennia time scales. Our results demonstrate that the variability of the solar activity could have impact on southern hemisphere weather and climatic conditions. We anticipate our analysis to be a starting point for more sophisticated weather and climatic models.

Keywords: energetic particles, intense magnetic storms, climate change

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JMS021 **Oral Presentation** **1348**

The Effects of Solar Proton Events on the Stratospheric Chemistry: MIPAS Measurements and Model Simulations

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In this paper we show the atmospheric composition changes in the polar stratosphere and mesosphere caused by particle precipitation associated with the enormous solar storm in Oct/Noc 2003 as recorded by MIPAS. The ability of this instrument to measure a large number of constituents, including O3, NO, NO2, HNO3, N2O5, HNO4, ClONO2, ClO, HOCl, and H2O2, during such enourmous storm makes it very suitable for investigating its effects on the stratospheric polar chemistry. We report the short-term (days) temporal evolution of the significant increase in NOx and decrease in O3. As a consequence of the NOx changes, alterations in other NOy and chlorine species are also observed, e.g., in HNO3, N2O5,HNO4, ClONO2 and ClO. The HOx composition is also perturbed by the solar proton events and evidence is given by HOCl and H2O2 observations. Most of the changes are observed in both, the northern (winter) and southern (summer) polar regions. These atmospheric composition changes have been studied by 1D and 2D models. While some changes are well understood (NOx, O3), others are not so clear (HNO3, N2O5, ClONO2, HOCl) and might require the revision of the chemical processes involved. Favored by the dark condition and the downwards transport in the 2003-2004 NH polar winter, the in situ production of NOx in the stratosphere has also mid-term (months) effects on stratospheric polar ozone. To quantify the O3 loss due to the solar storm, model runs with the 3D KASIMA model have been performed where NOx enhancements in the lower mesosphere have been constrained by MIPAS observations. The results show a significant O3depletion in the mid-upper polar stratosphere in this winter and subsequent spring.

Keywords: spe, stratospheric chemistry, mipas

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JMS021 **Oral Presentation** **1349**

Observing Nitric Oxide in the Polar Night

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There is strong evidence that NO is a key coupling agent by which the magnetosphere channels solar energy through energetic particle precipitation in the polar night. While NO has long been understood as an important species in the upper atmosphere, its highly variable abundance has only been measured during sunlit conditions. The lack of nighttime measurements is a crucial gap in our knowledge as there is a large and rapidly growing body of evidence that NO created by energetic precipitating particles, after being transported to the lower atmosphere during polar night, has a significant and potentially long term effect on stratospheric ozone distributions and thereby possibly climate. We describe a spaced-based experiment that will utilize, for the first time, stellar occultation as a method for obtaining nighttime NO concentrations in the mesosphere-lower thermosphere (MLT) region. We utilize a moderately high resolution spectral measurement of the NO d-bands near 183 nm in absorption. This approach will be compared to other possible techniques. We describe the measurement capabilities required to obtain vertical profiles of NO in the polar night. We show that an instrument with appropriate light gathering capability can be made with mass and dimensions appropriate for sounding rockets and small satellites.

Keywords: instrumentation, thermosphere, nitricoxide

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JMS021 **Poster presentation** **1350**

Chemical atmospherical composition changes during 23-rd solar activity cycle induced by solar proton events: photochemical simulation ABD analysis of observation data

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Satellite observations of solar proton fluxes in different channels have been used to investigate proton solar activity during 23-rd cycle. The 20-23 solar cycles parameter comparison show that 22 one was the major SPEs. The 23-th cycle differs from another one by remarkable phenomenon: 3 very powerful solar events are occurred in its quiet phase. A full amount of SPE during 23 cycles was weaker but its energy fluxes were increased proton fluxes with energy value more than 100 MeV are observed in 37% of SPEs. Several most forceful SPE were chosen for model investigations. Ionization of the atmosphere caused by the strongest SPE was calculated. Integral ions quantity was estimated. Ion pair maximum creation in atmosphere was during SPE 14.07.2000, 04.11.2001 and 28.10.2003. It was found the ionization structure differs for individual SPE: maximum of ionization rates was as lower as more proton fluxes in high energetic spectrum diapason were (>95 MeV). The ionization maximum situation was lower during SPE 04.11.2001 and 08.11.2000 beside 48-50 km. It was shown by photochemical calculations that the same SPEs were most effectively affected on atmosphere. The ozone depletion in stratosphere and mesosphere was strongest in periods of SPE 08.11.2000 and 04.11.2001 91.4% and 72.8% in layer 40-60 km (0.9% and 1.1% in atmospherical column (0-88 km)) respectively, but not for famous SPE 14.07.2000 55.8 % in 40-60 km (0.2 % in column). According to photochemical simulations results, 1) the response on SPE the atmospherical composition depends on proton fluxes, of its energy spectrum and season; 2) the [O3] changes was more essential in condition of long light day (polar day), but changes can conserve for a more long time in the short light day conditions (polar night).

Keywords: protons, ozone change, ionization of atmosphere

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JMS021 **Poster presentation** **1351**

Solar proton event of 14 July 2000: Influence on earths atmosphere neutral and ionized composition according photochemical simulations for polar regions (70 N AND 70 S)

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The response of the neutral and ionized composition in the middle atmosphere after one of the strongest solar proton events (SPEs) of 23rd solar cycle occurred 14 July 2000.was simulated. The enhancement of the solar proton fluxes (E > 10 MeV) was about 4 orders during this SPE. The response of the neutral and ionized composition in the middle atmosphere was simulated. The difference between Northern pole (N.P), day conditions, and Southern Pole (S.P.), night conditions, has been taken into account. The results of computations showed that ozone content was strongly reduced after SPE: over N.P. [O3] changes were about 80% at altitude 65-75 km, and only 25% at 55-65 km over S.P. The ozone behavior in separate layers was differing in day and night conditions. Such ozone depletion is consequence of [NO] and [OH] amount enhancement caused by increased ionization. It was found also the electron density was increased about 3-4 orders over N.P. and S.P at 50-80 km. The calculations results for [NO] and [O3] changes have rather qualitative suitability with observations data from satellites (UARS, HALOE for N.P.), although the simulated differences for [NO] were twice larger, than the observed ones.

Keywords: solarprotons, ionization, ozone

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JMS021 **Poster presentation** **1352**

Atmospheric chemical changes in Polar cups during December 2006

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December 2006 was characterized by elevated solar activity. Data from GOES (Geostationary Operational Environmental Satellite) series were used to identify two intense SEP (Solar Energetic Particle) events starting on 7 and 13 December 2006, respectively. These solar particles, driven by the spiral field lines of the interplanetary magnetic field, hit the Earths atmosphere and increased the ionization rate mainly below about 100 km. Moreover ionization, dissociation, dissociative ionization and excitation phenomena initiated the variability of the neutral atmospheric components. The induced rise of NOx and HOx species caused the starting of catalytic cycles for the ozone destruction. We used data from different satellite sensors (mainly Limb scattering and Limb emission techniques) to investigate the mesospheric and stratospheric chemical response to the two SEPs in the Northern and Southern high latitudes during December 2006.

Keywords: ozone, solar energetic particle

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JMS021 **Poster presentation** **1353**

Simulations of the effect of ionizing particle precipitation on the middle atmosphere

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The Canadian Middle Atmosphere Model (CMAM) is a coupled chemistry-climate model which extends from the surface up to about 98 km. It includes realistic implementations of the major physical and chemical processesnecessary to represent the complexity of interactions throughout the model domain. The CMAM has been used in several multi-year experiments to study the impact of observed solar proton events, auroral precipitation andparameterized galactic cosmic rays on the middle atmosphere. Penetration of ionizing particles from space can substantially modify the composition of the middle atmosphere, its energy budget and dynamics. Persistent auroral precipitation affects primarily the upper mesosphere but under the right transport conditions can influence the stratosphere. Strong but sporadic solar proton events and galactic cosmic rays can penetrate deeper into the stratosphere. The effect of ionizing particle precipitation varies in response to changes in solar activity and the terrestrial magnetic field. Individual and combined effects of different particle precipitations at different levels of solar and magnetic actitivy are shown and analyzed.

Keywords: aurora, ionization, ccm

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JMS021 **Poster presentation** **1354**

Upper-Mesospheric Temperatures measured during the January 2005 Solar Proton Events

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A large solar flare and the associated coronal mass ejection on 20 January 2005 marked the start of the so far hardest and most energetic solar proton event (SPE) in the Solar Cycle 23. The proton event lasted till about 18 UT on 22 January. From about 18-07 UT on 21-22 January we measured the upper-mesospheric temperatures above the island Andoya in using the ALOMAR Weber Na lidar. These measurements give us the opportunity to look for possible temperature effects caused by the extraordinary SPE. We use particle detectors on NOAA 15, 16 and 17 together with the Imaging Riometers in Kilpisjrvi, (IRIS) to monitor the local energetic particle precipitation. The presence of gravity and tidal waves causes, however, a complicated temperature and wind field in the actual height region. We therefore have to make a rather challenging wave analysis before looking for possible temperature changes caused by energetic electron precipitation. We present and discuss our analyzing method, together with our conclusions.

Keywords: temperatures, upper mesosphere, spe

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JMS021 **Poster presentation** **1355**

Impact of tides on transport and constituents in polar regions: results from the extended canadian middle atmosphere model

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Jian Du

The polar regions in the mesosphere and lower thermosphere are the site of unique tidal features. These tides transport and modify the chemistry of constituents throughout this region. A one year run of the extended Canadian Middle Atmosphere Model (CMAM) is used to characterize the tidal signatures in this region. Semidiurnal and terdiurnal (as opposed to diurnal) migrating and non-migrating tides dominate in the polar region. Significant amplitudes from wave 0 through wave 4 appear in the model run. In this paper the wind and temperature signatures of these components are discussed and their seasonal variation presented. Assuming quasi-adiabatic motion, the vertical variation in air parcel motion and the potential impact on constituent concentrations is determined. The horizontal motions associated with each component of significant amplitude are identified and their cumulative effect is calculated. Because of the periodic nature of the tidal motions, constituent observations must be interpreted carefully. These variations may affect how energetic particle affect the stratosphere and mesosphere and how these signatures are observed. Simulations using the derived amplitudes from the model are used to illustrate these issues.

Keywords: tides, polar regions, trasport

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JMS022 **1356 - 1373**

Symposium
Solar Impact on the Mesosphere-Stratosphere-Troposphere System

Convener : Dr. Ulrike Langematz

The session will address the identification of the solar signal based on observational datasets ranging from the upper atmosphere (thermosphere, mesosphere) to the troposphere, the Earth's surface and the oceans. It will further focus on the physical and chemical processes leading to the observed solar signal, including those due to variations in electromagnetic radiation and energetic particle precipitation. Simulations with mechanistic, general circulation and chemistry climate models are especially encouraged. Studies on the variations on different time scales ranging from the 27-day rotation period over the 11-year solar cycle to centennial variations including the Maunder Minimum are welcome

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JMS022 **Oral Presentation** **1356**

Solar impact on the gas composition and structure of the atmosphere evaluated with a Chemistry-Climate Model

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Smyshlyaev Sergey, Galin Vener

Effects of variations in solar spectral irradiance during the 11-year cycle on gas composition and temperature have been estimated with the 3-D global climate-chemistry model (CCM) consisting of the chemistry-transport model (CTM) developed in RSHU interactively coupled with general circulation model (GCM) of lower and middle atmosphere of DNM (Department of Numerical Mathematics, Russian Academy of Sciences). Measurements show that 10 to 20% of solar cycle irradiance changes occur in the ultraviolet (UV) radiation, which is responsible for the formation of stratospheric ozone. Absorption of solar radiation in the UV is largely responsible for determination the thermal, and sense dynamical, structure of the lower and middle atmosphere. Feedbacks between the chemical and physical processes have both quantitative and qualitative impacts on the atmospheric climate. The model has global coverage and includes 31 altitude levels extending from the surface to 90 km. Photolysis rates and atmospheric heating are varied during the solar cycle simulation in accordance with observational satellite data of UV flux over the several solar cycles. Basic results and conclusions of numerical experiments of the solar effects on the temperature and ozone variability with the 3-D interactive chemistry climate model during 1979-2005 cycle and comparison with observations are presented. Implicit influence of solar variability on the climate change due to feedback between temperature, circulation and gas composition variability was found to be significant compared to the direct effects.

Keywords: modeling, solar cycle, atmospheric gas composition

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JMS022 **Oral Presentation** **1357**

Zonally asymmetric ozone in the stratosphere and its relevance for solar impact on atmospheric dynamics

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Axel Gabriel

For boreal winter decadal averages of zonally asymmetric ozone are calculated from ECMWF Reanalysis (ERA-40). With the GCM MAECHAM5 we investigate the impacts induced by solar radiation perturbations on temperature and planetary Rossby wave propagation characteristics in the tropo-, strato- and lower mesosphere. The analyzed stratospheric ozone of ERA-40 shows a strong increase in wave 1 structure during the last decades, with amplitudes of about 10% of the zonal mean ozone during the 1990ies. The vertical structure is in agreement with SAGE measurements. Based on a set of model calculations, we found that the related radiation perturbations induce significant changes in temperature increasing with height (we found maximum changes of about -4 K in the lower stratosphere and -8 K in the lower mesosphere) due to an induced increase in amplitude and shift in phase of the stratospheric wave 1, i.e. an enhancement and shift of the polar vortex. Further, the accompanying changes in three-dimensional wave activity flux vector reveal that regions of strong vertically propagating wave trains become much weaker over the Asian / North Pacific region and much stronger over the North America / North Atlantic region. The feedback mechanism of controlling synoptic Rossby wave breaking through polar vortex shifts induced by zonally asymmetric ozone which altering the balance between large-scale dynamics and Rossby wave propagation will be discussed.

Keywords: solar, ozone, dynamics

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS022 **Oral Presentation** **1358**

Revealing a role of solar signal in optical parameters of the atmosphere

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Dmitri Ponyavin

The aim of our research is to study solar and space factors that may affect atmospheric parameters and climate of the Earth. The main question is - how do lower layers of the Earths atmosphere respond to the solar variability and what can be a mechanism behind that. Here we present some new results of studying influence of solar activity on transparency of the atmosphere and optical aerosol parameters. This investigation is continuation of our previous efforts on finding the effect of long- and short-term variations of solar activity in the variations of parameters of the lower atmosphere and the optical properties of atmospheric aerosol such as aerosol backscattering profiles from background lidar measurements. Now we added to our analysis satellites information about aerosol optical properties, such as variations of aerosol optical depth (aerosol index TOMS). The TOMS (Total Ozone Mapping Spectrometer at NASA spacecraft) aerosol index is related to aerosol optical depth, which, in turn, indicates how much light is scattered or absorbed by particles while passing through a column of the atmosphere. The daily variations of aerosol index of TOMS are analyzed from 1996 to 2005. The great amount of the data distributed over the world allows us to consider separately variations of aerosols over Equator, Northern and Southern Hemispheres. It is found that an increase of penetrating solar cosmic rays into atmosphere of the Earth have different influence on the aerosol particles at various latitudes. Opposite effect has place after decrease of intensity of galactic cosmic rays.

Keywords: solar activity, aerosol index toms, cosmic rays

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JMS022 **Oral Presentation** **1359**

The role of the QBO in simulating the solar signal in the middle atmosphere and its transfer to the troposphere

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Rolando Garcia, Dan Marsh, Anne Smith

Solar influence on climate is a current research topic in many observational and modeling studies. To understand the response of the middle atmosphere to the 11-year solar cycle and its possible transfer to the troposphere we will investigate a comprehensive set of experiments made with a state-of-the-art chemistry climate model that incorporates the whole atmosphere up to the thermosphere. We will discuss especially the role of an externally prescribed stratospheric QBO in influencing the 11-year solar cycle signal in NCARs Whole Atmosphere Community Climate Model (WACCM3). 110-year sensitivity experiments with WACCM3, in which we included only a realistic time varying solar cycle, only a synthetic, time varying QBO or both the solar cycle and the QBO, will be analyzed to investigate the role of the QBO for the solar signal. The mechanism for solar influence on climate will be studied as well. In these simulations the sea surface temperatures had a repeating climatological seasonal cycle and the greenhouse gases were set constant to 1995 conditions.

Keywords: solar influence, qbo, modeling

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JMS022 **Oral Presentation** **1360**

Year-to-year variability in mesospheric temperature, its stratospheric connection and possible solar cycle origin

Prof. Gordon Shepherd
CRESS York University IAGA

Young-Min Cho

Mesospheric and Lower Thermosphere (MLT) rotational temperatures have been observed for the OH airglow emission near 87 km and the O2 Atm airglow emission near 94 km for five years at Resolute Bay (74 N) in Northern Canada, beginning in 2001. A high degree of variability is observed during single winters, but also a large variation from one winter to the next. At these latitudes both warm and cool mesospheric winters occur. This is found to be connected to the stratosphere, as warm mesospheric winters correspond to warm stratospheric winters, as determined from radiosonde measurements from the same location. The warmest winter was 2001-02, near the peak of the solar cycle, with cooler winters since then. This suggests the possibility of a solar connection, but with such a short dataset, it remains only a possibility. Most other investigations of mesospheric temperature at high latitude have found no correlation with the solar cycle. These results are described and discussed in this presentation.

Keywords: temperature, mesosphere, stratosphere

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JMS022 **Oral Presentation** **1361**

Solar influence on the Indian Ocean through stratospheric dynamical processes

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Kiyotaka Shibata, Katie Coughlin

Solar influence on the tropical stratosphere and troposphere in northern summer is studied by using reanalysis data from 1958 to 2004. Temperature tendency and vertical velocities are investigated to demonstrate an importance of the development of solar signal from June to August. The use of the temperature tendency reduced a problem due to the change of the observation system, and made possible to revealed a clear relationship between the stratospheric meridional circulation and the Indian ocean monsoon circulation in the troposphere through four solar cycles. Change of the Indian Ocean monsoon circulation further impacts on the extension of the El Nino/Southern Oscillation (ENSO) related variability from Pacific to the Indian Ocean. Although, the Indian Ocean Dipole (IOD) mode and ENSO are separate atmosphere-ocean coupled phenomena, coupling occurs under certain conditions, that ENSO-related variability extends into the Indian Ocean, led by a developed South Indian Ocean (SIO) anticyclone, during periods of low solar (LS) activity. During periods of high solar (HS) activity, anomalous sea surface temperatures are confined to the Pacific with little amplification of the anticyclone in the South Indian Ocean. The direct cause of the difference in the SIO anticyclone arises from a shift in the location of the descending branch of the anomalous Walker circulation. This can be attributable to a change in the background Indian Ocean monsoon circulation modulated by changes in solar activity.

Keywords: solar, climate, tropics

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JMS022 **Oral Presentation** **1362**

Solar and QBO effects on the modes of low-frequency atmospheric variability in the Northern Hemisphere

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Lucie Pokorn, Josef BochnčEk, Pavel Hejda

Our recent results indicate that the shapes, spatial extent, and intensity of modes of low-frequency variability of atmospheric circulation (also called teleconnections) in the Northern Hemisphere in winter are significantly affected by the phase of the 11-year solar cycle. Here we extend the analysis by further subsampling the data by the phase of the quasi-biennial oscillation (QBO). The winter months (December to March) are stratified by the solar activity into two (below / above median) or three (low, moderate, and high) classes, and each of these classes is subdivided by the QBO phase (west or east). The teleconnections are determined by rotated principal component analysis of 500 hPa heights separately in each class of solar activity and QBO phase. The analysis is based on the NCEP/NCAR reanalysis and covers period 1953-2001. Detected are all the modes known to exist in the Northern Hemisphere mid and high latitudes, including among others the North Atlantic Oscillation, Pacific / North American pattern, West Pacific Oscillation, and North Asian pattern. The stratification by the QBO phase strengthens the effects of solar activity alone (namely, a tendency to zonalization of the modes, their larger spatial extent, and relatively greater intensity of the zonal modes under a high activity) for the west QBO phase.

Keywords: solar activity, qbo, tropospheric circulation

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JMS022 **Oral Presentation** **1363**

Photochemical and dynamical effects of the 11-year solar cycle signal on stratospheric ozone and temperature

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Previous modeling studies have found that an accurate treatment of the equatorial winds throughout stratosphere, including the quasi-biennial oscillation (QBO) and semi-annual oscillation (SAO) may be important for simulating an extratropical response to solar UV forcing over the 11-year cycle. This extratropical response is thought to be a likely feedback mechanism for translating solar UV variations into a global climate response. However, there are still significant discrepancies between the modeled and observed solar cycle variations in middle atmosphere composition (e.g., ozone) and dynamics (e.g., winds, temperatures) that remain unresolved. This presentation will discuss results from a series of 50-year model simulations using a new high-vertical resolution version of the zonally averaged CHEM2D model. These 50-year experiments include external forcing by decadal variations in solar UV irradiance, and internal forcing through an imposed decadal variation in planetary wave amplitudes. The results of the CHEM2D model experiments will be compared with recent 3D model simulations of the solar cycle impact on middle atmosphere dynamics and with the latest satellite-based estimates of 11-year variations in stratospheric ozone and temperature.

Keywords: solar, stratosphere, ozone

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JMS022 **Oral Presentation** **1364**

Effects of energetic particle precipitation on the stratosphere: Solar cycle variability

Dr. Cora Randall

Scott M. Bailey, Peter F. Bernath, V. Lynn Harvey, Charles H. Jackman, Daniel R. Marsh, Chester Rubbo, James M. Russell, Iii, Annika Seppala, David E. Siskind

It is now well documented that nitric oxide produced in the thermosphere or mesosphere by energetic particle precipitation (EPP-NOx) can descend in the polar night to the stratosphere, where it participates in catalytic ozone destruction. This talk focuses on the magnitude and variability of this coupling during the last two decades. The two factors controlling EPP-induced thermosphere/stratosphere coupling include the numbers & energies of precipitating particles, which determine the amount and altitude of NOx produced, and the efficiency with which the NOx is transported downward. This is because NOx transported out of the polar night before reaching the lower mesosphere is usually destroyed via photodissociation of NO. We will show recent work that suggests that in the southern hemisphere, solar cycle variability in the amount of EPP-NOx reaching the stratosphere depends primarily on variability in the first factor. In the northern hemisphere, however, the second factor variations in meteorology appear to be more significant for driving solar cycle variability in the coupling. During Feb-Mar of 2004 and 2006, for instance, more EPP-NOx was observed descending into the Arctic stratosphere than had ever before been observed, even in the south. In both of these winters, meteorological conditions were exceptional, and favored strong, confined descent of NOx to the stratosphere. Although the Halloween storms of 2003 could have influenced the coupling in 2004, particle precipitation was lower than average in the winter of 2005-2006. This leads to the conclusion that unusual meteorological conditions can result in substantial thermosphere/stratosphere coupling, even in the absence of strong EPP. The results highlight the importance of a comprehensive understanding of mesospheric dynamics and its interannual variability.

Keywords: particle precipitation, stratosphere, nox

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JMS022 **Oral Presentation** **1365**

Long-term changes in Polar Mesospheric Clouds: How the new NASA AIM satellite mission will address the underlying causes

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The Aeronomy of Ice in the Mesosphere (AIM) satellite is scheduled to be launched in April, 2007, as the first satellite mission dedicated solely to the study of Polar Mesospheric Clouds (PMC), known historically as Noctilucent Clouds. On board the polar orbiting spacecraft are three instruments designed respectively to image clouds at high spatial resolution, to measure high-precision profiles of PMC, temperature, water vapor and other species in the mesopause region, and to detect incoming cosmic dust particles. The overall goal of AIM is to determine how mesospheric clouds form, and why they vary with season, latitude and hemisphere. Concurrently operating during the two-year AIM mission will be three SBUV/2 spectrometers flying on NOAA satellites. This continues an unbroken 28-year time series of UV earth albedo measurements, which are primarily designed to measure atmospheric ozone, but used also to monitor PMC brightness and occurrence frequency since 1979. Analysis of the seasonally-averaged SBUV brightness residuals has shown a clear signal of a long-term brightness increase of PMC, along with an 11-year modulation anti-correlated with solar activity. We will describe a method to inter-compare AIM high-resolution images (2 km at nadir) with the long-term SBUV photometric data sets (170 x 170 km resolution). In addition, since there will be co-located measurements of PMC, temperature, water vapor and other forcing variables taken in coincidence by the AIM solar occultation instrument, there is the opportunity to assess the underlying causes of PMC variability. Linking the AIM and SBUV measurements may therefore reveal the mechanisms of solar and long-term changes.

Keywords: mesosphere, polar mesospheric clouds, trends

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JMS022 **Oral Presentation** **1366**

The 11-year solar cycle variation of stratospheric ozone as obtained from the SBUV ozone profile measurements

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The observed solar cycle variation of ozone is a key constraint on climatemodels that include solar UV / ozone / dynamical coupling as a sun-climate forcing mechanism. Previous empirical analyses indicate that the largest percentage ozone increase from solar minimum to maximum is in the upper (1-3 hPa) and lower (30-100 hPa) tropical and subtropical stratosphere while a minimum percentage increase occurs in the tropical middle stratosphere (5-10 hPa). This observationally derived altitude dependence in the middle and lower stratosphere contrasts with the results of radiative-photochemical models which predict a maximum ozone increase in the middle stratosphere and a small increase in the lower stratosphere. Here, we apply standard multiple regression statistical model to estimate the 11-year solar cycle component of stratospheric ozone variability using the Version 8 SBUV (/2) satellite ozone profile data set over the 1979 to 2003 time period. Results show strong ozone responses in the low-latitude upper and lower stratosphere (2-3 % of the annual mean) and negligible ozone response in the low-latitude middle stratosphere. Our analysis shows that the geographical position of this tropical 3-cell structure appears to be sensitive to the season: in summer (JJAS) the area of the minimum ozone response in the tropical middle stratosphere spreads into the southern hemisphere up to 150S, while in winter (DJFM) the area of the minimum ozone response is between the equator and 150N. We suggest that such seasonal displacement is related to the solar induced changes in the stratospheric dynamics.

Keywords: ozone, solar, stratosphere

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JMS022 **Poster presentation** **1367**

The Relationships of Solar Activities with Sea Surface Temperature (SST) and ENSO Over Indonesian Regions

Mr. Tiar Dani

Wilson Sinambela

This paper presents the relationships between long-term solar activities and sea surface temperature (SST) anomalies over Indonesian regions. Analysis on the relationships between these parameters is carry out by using wavelet-base analysis techniques and correlation analysis. The wavelet transform-base analysis (WWZ) for SST anomaly time series grouped for overall Indonesian SST (SSTI), Western Indonesian SST (SST KIB), Middle Indonesian (SST KITeng) and Eastern Indonesian SST (SST KIT) during the periods of 1860-2005. The WWZ result for SST anomaly time series over Indonesia show some long period main signals with periods of 83 year, (50,33, 25) year, (9-13) year which are suspected to be associated with solar activity cycles of 80-110 year (Gleissberg cycle), 50 year (interdecadal cycle), 22 year (Hale cycle) and 11-year of solar activity. There are also appear some signals with shorter periods of (3-7) year, (1.5- 2.7) year, and (0.5-1) year which are suspected to be associated with ENSO, QBO, and seasonal/annual effects, respectively. From the results of long-term correlation analysis between solar activities with solar cycle length indicators and the 11 and 22 year running moving average Indonesian SST anomalies show good correlation for all data group.

Keywords: solar activities, sst, indonesia

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JMS022 **Poster presentation** **1368**

Solar variability effects on meridional winds in the mesosphere from the Imaging Doppler Interferometer at Halley, Antarctica

Dr. Elaina Ford

Rob E. Hibbins, Martin J. Jarvis

Meridional winds from the Imaging Doppler Interferometer (IDI) at Halley, Antarctica (76S, 27W), have been compared with solar output through the F10.7 index. Winds are available from 55 105km altitude, and are binned in 5km steps. Data are available from 1996 to the present, and so cover a full solar cycle. Diurnal and semi-diurnal tides have been computed on a 4-day running basis. Both these and the monthly mean climatology have been removed from the data to leave the residual variability. A variation in the average meridional wind speed is seen over the range of F10.7, and this is strongest in the highest altitude bin from 100-105km. Splitting the data set according to the phase of the quasi-biennial oscillation in the equatorial stratospheric winds shows a difference in this correlation with F10.7 between the total data set and the easterly and westerly phases. This suggests a link between the high latitude mesospheric winds and solar output, and also indicates a coupling to the equatorial stratosphere. Correlations between the meridional winds from IDI and the Ap index are smaller, implying that geomagnetic activity has a lesser influence on the mesospheric winds than does solar irradiance.

Keywords: solar variability, mesosphere, qbo

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JMS022 **Poster presentation** **1369**

Lunar variation of precipitation

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The phenomenon of correlation of precipitation amounts with lunar phase (synodic month) was studied in details during the 1960s by many authors worldwide, e. g. by Bowen in Australia, Andrlik in former Czechoslovakia and Bradley et al. in the USA. It was demonstrated that extreme precipitation events occur more frequently on the third to fifth day after syzygies and variation of ice nuclei of meteoric origin was suggested as possible mechanism. The hypothesis was supported by observed frequency of radar meteor rates and by links of precipitation singularities with peaks of activity of specific meteor streams. The idea was not generally accepted and awareness of scientific community of the effect slowly died away. In our previous papers we found that it was probably due to long-term shifts of the lunar signal. The classic picture of increase of mean daily rainfall some 3-5 days after both new and full moons (Bowens signal) disappeared for decades. We tried to understand this phenomenon by statistical analysis of extraordinary long precipitation data at Prague-Klementinum (daily rainfall data in 1806-2006), at another secular stations in Bohemia and also at a sort of European stations in 1900-2001. The results supported important role of lunar tides in the variation but until now we did not look for further physical explanation. Our recent study revealed unexpected influence of solar activity. We used correlation coefficient between mean synodic rainfall courses with simple cosinus shifted by 4 days as a measure of presence of Bowens signal. Its amplitude, smoothed by 11 years, undergoes quasi-periodical variations with the largest changes occurring at most cases two years before solar activity minima. The data suggest that the sign of the changes alternates in 22-year rhythm what may imply the role of solar magnetic (Hale) cycle. According to latest ideas about the modulation of galactic cosmic rays by solar polar field reversals and about the role of galactic cosmic rays in cloud microphysical processes we propose rather complicated but plausible physical chain: orientation of solar magnetic field different types of interaction with Earths magnetosphere during even or odd solar cycles modulation of the magnetosphere by the Moon semilunar variation of cosmic rays changes in CCN formation lunar variation of precipitation.

Keywords: precipitation, moon, hale cycle

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JMS022 **Poster presentation** **1370**

Eleven-Year Solar Cycle Signals in the Middle Atmosphere: Chemistry-Climate Model Simulations for the Recent Past 1980-2004

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Makoto Deushi

It is well known that solar variations affect the stratosphere as well as the troposphere. Above all, the 11-year solar cycle is the most prominent cycle giving rise to large impacts on the stratospheric temperature and ozone through substantial irradiance variations of about several % at UV wavelengths. Though the total solar irradiance variation of the 11-year solar cycle is at most 0.1 %, its signal can be evidently detected from the upper stratosphere down to the surface in the observed geopotential data. Indeed the 11-year solar cycle effect on the upper stratosphere is straightforward enough to be readily understood as a direct result of the UV irradiance changes, but its indirect effect through dynamics on the lower stratosphere is not necessarily well clarified as for the mechanism. In this study, the 11-year solar signals were investigated in the simulation of Meteorological Research Institute chemistry-climate model (MRI-CCM), which was driven by observed forcings for the recent past 1980-2004. MRI-CCM is based, for a dynamical module, on a MJ98 GCM with an eta-ordinate [Shibata et al., 1999]. To reproduce the quasi-biennial oscillation (QBO) in the tropical stratosphere, the non-orographic gravity wave drag (GWD) scheme of Hines [1997] is incorporated with enhanced gravity wave source over the tropics, instead of Rayleigh friction. In addition, the biharmonic horizontal diffusion is weakened in the middle atmosphere, where the e-folding time at the maximum wavenumber 42 is set at 150 hrs, being slightly less than the previous value of 180 hrs [Shibata and Deushi, 2005a]. The chemical module includes 36 long-lived and 15 short-lived species with 80 gas-phase reactions, and 35 photodissociations with 9 heterogeneous reactions. MRI-CCM has a horizontal resolution of 2.8 by 2.8 degrees (T42) in longitude-latitude space and has 68 layers (L68) extending from the surface to the mesopause (~0.01 hPa) with 500m vertical spacing from 100 to 10 hPa. MRI-CCM adopts a hybrid semi-Lagrangian transport scheme, in which a new PRM5 scheme is developed by improving both vertical and horizontal procedures to simulate better distributions of chemical constituents; the vertical procedure employs the piecewise rational method (PRM) [Xiao and Peng, 2004] and the horizontal procedure uses a quintic interpolation.Ensemble CCMsimulation was made under the CCMVal REF1 scenario [Eyring et al., 2005], in which both natural and anthropogenic forcings of SST, sea-ice, greenhouse gases, halogens, the 11-year solar cycle, and volcanic aerosols are given daily through interpolation from monthly mean values. The integration period covers the period from November 1979 to December 2004, prior to which spin-up integration was made for more than several years. The general conditions of the REF1 are described in Eyring et al. [2005]. There are two giant volcanic eruptions, El Chichn (7.4 N, 93.2 W) in March/April 1982 and Mount Pinatubo (15.1 N, 120.4 E) in June 1991, over the entire integration period. Linear multiple regression analysis is used to isolate specific signals from the anomalies in temperature and ozone data for the simulation and observations. Reference variables are the mean value, the linear trend, the QBOs at 20 and 50 hPa, volcanic aerosols of El Chichn and Mount Pinatubo , El Nio/Southern Oscillation (ENSO), and the 11-year solar cycle. It is found that MRI-CCM can more or less realistically reproduce observed trend of annual-mean temperature and ozone. The annual-mean QBO signals of temperature and ozone is well reproduced as for the meridional structures. The seasonality of the mid-latitude total ozone QBO is also quantitatively reproduced including extensions to hi-latitudes in winter hemispheres. The vertical three-cell of alternating sign (positive in the upper stratosphere, negative in the middle stratosphere, and positive in the lower stratosphere) in the tropical stratospheric temperature due to the 11-year solar cycle is qualitatively reproduced. On the other hand, the simulated

ozone reproduced positive signals in the upper and lower stratosphere, but did not exhibit negative signal in the middle stratosphere.

Keywords: 11 yr solar cycle, chemistry climate model, ozone

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JMS022 **Poster presentation** **1371**

Common oscillatory modes in geomagnetic activity, NAO index and surface air temperature records

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Milan Palus

Detection and extraction of quasi-oscillatory dynamical modes from instrumental records of geophysical data became a useful tool in analysing variability of observed phenomena reflected in complex, multivariate geophysical signals. Using the extension of the Monte Carlo Singular System Analysis (MC SSA), based on evaluating and testing regularity of dynamics of the SSA modes against the colored noise null hypothesis, we demonstrate detection of oscillatory modes with period about 96 months in the long-term records of aa-index as well as in the records of surface air temperature from several mid-latitude European locations, and in the North Atlantic Oscillation index.

Keywords: climate, variability, modes

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JMS022 **Poster presentation** **1372**

The role of dynamical variability for communicating the 11-year solar signal

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Anne Kubin, Kunihiko Kodera

We present a model study in which we investigate the role of interannual variability in the subtropical lower mesosphere as dynamical mechanism to transfer the solar signal. We conducted 11-year solar maximum and minimum experiments using the ECHAM5/MESSy climate model system. The extended radiation code FUBRad was included enabling the model to better represent UV changes associated with the solar cycle. Spectral irradiance and solar cycle induced ozone changes were prescribed. The model was used in the T42L39 resolution to perform a 50-year solar minimum and maximum equilibrium simulation, respectively. Compared to our previous studies the model simulates an improved poleward-downward movement of zonal wind anomalies during northern winter. Kodera et al. (2003) argued that the interannual variability of the subtropical mesospheric jet in early to mid winter plays a crucial role in transferring solar induced zonal wind anomalies poleward and downward throughout winter. Based on our multi-year model simulations and updated observational data we are able now to study the proposed mechanism in more detail.

Keywords: solar variability

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JMS022 **Poster presentation** **1373**

Large scale variation and trends in Convective Available Potential Energy (CAPE) over Chennai, Kolkata, and Delhi using radiosonde

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V. Panwar, R. Sapra, R. Bhatnagar, M. Kaur

In this paper we have used 17 years of radiosonde data at Chennai (Madras), Kolkata (Calcutta), and Delhi stations over Indian longitudes and derived convective available potential energy (CAPE) starting from year 1989 to 2005 at 1200 Hrs GMT. The stations are located at 13.4 N, 80.1 E, 22.3 N, 88.2 E, and 28.4 N, 77.1 E, respectively. CAPE represents the amount of buoyant energy available to accelerate a parcel vertically, or the amount of work a parcel does on the environment. The higher the CAPE value the more energy is available to foster storm growth. Relationships between CAPE and convective triggering frequency, or intensity are not so clear, however, long-term changes in CAPE might be associated with changes in convective activity and the atmospheric energy budget. CAPE is thus a potential indicator of climate change. We have investigated annual variation in the CAPE with dominant semiannual variation (seasonal variation) peaking around in the month of April and October, at Chennai and Kolkata stations, except at Delhi where a broad peak is noted. The values ranged 2000-4000 m2/s2 for maxima during summer and almost zero for minima during December months in the Indian region. Two seasonal peaks were found correspond to the timings of pre-Indian summer monsoon and winter returning monsoon. CAPE is an indicative of the measure of convection activity in the region. Analysis shows the larger values of CAPE exist during April-May than October. There is a latitudinal variation in the timings of maximizing the CAPE, it peaks first at Chennai than at Kolkata and finally at Delhi as per the progression of monsoon system to the north from equator. We have examined the 11 year solar cycle association to this parameter. Rising trend of CAPE is noted at Kolkata station only when the entire data of 17 years were used. We have prepared 3 segments of the data based on solar maxima (year 1989) to solar minima (year1995) and then again to solar maxima (year 2000) and so on to inspect the solar cycle effect. Segments of data at all stations show similar trends during 1989-2000 i.e. the CAPE showed a rising trend during 1989-95 and decreasing trend during 1996-2000. These segment trends are noticed opposite to the solar cycle trend. That indicates convection system organization and its intensity could be oppositely related to solar cycle. These are the preliminary results for the trends, as we have not removed annual cycle, quasibiennial oscillations (if exist) and some irregular periodicity effects such as El nino and volcanic eruptions.

Keywords: solar cycle, convective available, potential energy trends

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JMS023 **1374 - 1387**

Symposium
Instabilities in the Neutral Atmosphere, Ionosphere and Magnetosphere

Convener : Dr. James Hecht

Instabilities occur throughout the Earth's neutral atmosphere, ionosphere, and magnetosphere and their occurrence triggers numerous interesting phenomena that continue to be studied. These include Kelvin-Helmholtz instabilities near the mesopause and the magnetopause, and Rayleigh-Taylor instabilities in the ionosphere. This session will feature reviews, emphasizing the similar physics involved, of observations and modeling of instabilities that occur in these three regions. Contributions directly related to instabilities throughout the neutral atmosphere/ionosphere/magnetosphere are also welcome. Of particular interest are papers discussing instabilities in one regime which are either produced or are caused by phenomena in another

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JMS023 **Oral Presentation** **1374**

Characteristics of Short-Period Wavelike Features Near 87 km Altitude From Airglow and Lidar Observations Over Maui

Dr. James Hecht
Space Sciences Department The Aerospace Corporation IAMAS

R. J. Rudy, R. L. Walterscheid, A. Z. Liu, S. J. Franke, M. J. Taylor, P.-D. Pautet

Small scale (less than 15 km horizontal wavelength) wavelike structures, known as ripples are a common occurrence in OH airglow images. Recent case studies attribute their origin to the presence of either convective or dynamical instabilities. However, little is known about their frequency of occurrence and period. The Maui-MALT Observatory, located on Mt. Haleakala is instrumented with a Na wind/temperature lidar which allows the determination of whether the atmosphere is dynamically or convectively unstable, and a fast OH airglow camera which takes images every 3 seconds with a sensitivity high enough to see the ripples. This study reports on two months of observations in October/November 2003 and in August 2004, 8 nights of which also included Na lidar measurements. The imager results suggest that instability features occur in the 85 to 90 km region of the atmosphere around 20 percent of the time. The nominal observed period for the ripples is between 2 and 4 minutes. While there are clear night to night variations the average observed period is similar for both the 2003 and 2004 observations. In addition, a few of the small-scale structures are not ripples caused by instabilities, but rather have features consistent with their being short horizontal wavelength evanescent waves. Their fractional intensity fluctuations are as large or larger than those of the ripple instabilities. Unlike the instabilities, the origin of the evanescent waves is not determined.

Keywords: instabilities, airglow

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JMS023 **Oral Presentation** **1375**

Gravity wave instabilities and turbulence generation at large and small amplitudes and high intrinsic frequencies

Dr. Dave Fritts
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Gravity waves (GWs) exhibit a seemingly bewildering array of instabilities that span all wave amplitudes and intrinsic frequencies. Linear theory provides a useful guide to initial instability structures and growth rates at both large and small GW amplitudes, while numerical studies indicate a competition between 2D and 3D dynamics across the amplitude spectrum. The primary instabilities at small amplitudes (a ~ 0.7 or less) and high frequencies (~ N/3) are 2D interactions transferring initial GW energy to GWs having smaller vertical scales and lower frequencies. At larger GW amplitudes (a ~ 0.9 and larger), 3D dynamics predominate, but both 2D and 3D dynamics contribute to energy transfers. GW breaking at larger amplitudes proceeds rapidly, and leads to large amplitude reductions and a broad inertial range of turbulence on time scales of ~ 1 2 GW periods. The turbulence is strongly correlated with the GW phase, but is also highly variable in intensity and remains highly anisotropic throughout the evolution. As turbulence subsides, a quasi-2D motion field remains and dominates the variances and fluxes at late times.

Keywords: gravity waves, instability, turbulence

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JMS023 **Oral Presentation** **1376**

Simulations of Farley-Buneman instability: new hybrid approach

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Dmitry V. Kovalev, Yakov S. Dimant

The Farley-Buneman (FB) instability is a two-stream low-frequency plasma instability observed in the E-region ionosphere where electrons are magnetized, while ions are demagnetized due to frequent collisions with neutral particles. The instability is caused by a sufficiently strong electric field perpendicular to a magnetic field and is usually excited in the equatorial and high-latitude electrojets. While nonlinear theory of the FB instability has been developed for many years, it is still far from conclusion. Nonlinear simulations of the FB instability are usually based on fully kinetic, particle-in-cell (PIC), or hybrid fluid for electrons, PIC for ions codes. Fully kinetic 3-D description of the FB instability up to its nonlinear saturation still represents a challenge even for modern supercomputers. In this paper, we present first results of a novel hybrid approach based on solving fluid equations for electrons and a kinetic equation for ions with the Bhatnagar-Gross-Krook (BGK) collision term. The advantage of this kinetic equation is that it includes the crucial effect of ion Landau damping while avoiding numerical noises associated with the finite number of randomly moving particles. Fluid description of electrons allows modeling the real electron mass. Our mathematical scheme combines a nonlinear convection-diffusion equation for isothermal electrons with the kinetic equation for ions and Poisson equation for the electric potential. We have developed a simulator optimized for computers with multiprocessor architecture. A series of first 2-D simulations have shown conformity of the results with theoretical expectations and previous PIC simulations. We have observed the following major effects: nonlinear saturation of the instability, increasing of wavelength in the quasi-steady saturation state, and deviation of dominating wavevector from the direction of the ExB drift velocity of electrons. Our simulator can perform numerical computations of the FB instability for different ionospheric conditions. For a more realistic description of the FB instability, we are planning to extend this approach to non-isothermal electrons and to the 3-D case.

Keywords: farley buneman, instability, modeling

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JMS023 **Oral Presentation** **1377**

New insights into ionospheric plasma instabilities at low, middle, and high latitudes

Prof. David Hysell
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Understanding the origin of certain plasma irregularities and instabilities in the Earth's ionosphere necessitates looking beyond conventional linear, local eigenvalue analysis in the perpendicular plane. Strong plasma shear flow in the equatorial bottomside F region are described by a non-normal system of equations, and eigenvalue analysis neglects fast-growing transient modes which may dominate during the growth phase of equatorial spread F. These include both electrostatic Kelvin Helmholtz-like and Rayleigh Taylor-type instabilities. At middle latitudes, wave modes with finite parallel wavenumbers can exhibit faster growth than purely field-aligned modes, and these may be primarily responsible for kilometric plasma waves observed in sporadic E layers. In the auroral electrojet, nonlinear mode coupling is now believed to cause the phase-speed saturation of Farley Buneman waves, and novel analysis methods are required to predict and interpret wave behavior quantitatively. These issues will be analyzed and demonstrated using ground-based radar data from Jicamarca, the Caribbean, and Alaska.

Keywords: ionosphere, irregularities, instabilities

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JMS023 **Oral Presentation** **1378**

An Overview of Wave-Driven Instabilities in the Upper Mesosphere and Lower Thermosphere

Dr. Richard Walterscheid
IAMAS

Waves can drive instabilities by causing regions of instability to occur in which growing disturbances can form, or by contributing to time-dependent background states on which growing disturbances can form, the simplest example of the latter being a time-independent mean-state plus a primary wave. In the first mentioned class of instability, the superposition of gravity waves and the mean state cause classical criteria for convective or dynamical instabilities to be met locally. Examples are super-adiabatic lapse rates (convective instability) and values of Richardson number < (Kelvin-Helmholtz instability). These criteria seem to provide a consistent explanation of transient small-scale features that are often seen in observations. However, wave structures occur in conditions that do not fit the classical view. A reasonable explanation is that they are disturbances on a wave background and occur because a primary wave forces coefficients of the governing equations to vary in time (a Floquet system when the parameters vary periodically). These disturbances can occur when conditions are stable according to classical criteria. This presentation will briefly review the classical instabilities (along with some caveats), and will review instabilities of the Floquet type (normal mode and singular vector) that might cause transient small-scale wave-like structure seen in radar and airglow observations.

Keywords: wave instabilities, dynamical instabilities, parametric instabilities

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JMS023 **Oral Presentation** **1379**

Turbulence generation by gravity waves

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Florian Zink

The analysis is discussed of data acquired in 17 high-resolution thermosonde observations made in a campaign near Adelaide, Australia. The observed fraction of turbulent layers is consistent with their generation by instabilities due to internal gravity waves if rotational effects are included. Using Monte Carlo simulations it is shown that the observed distribution of turbulent layer thickness is consistent with an -3 slope for the gravity wave vertical wavenumber spectrum. Simulations of the wave field as a function of height and time also show good qualitative agreement between turbulent layer structures and radar observations.

Keywords: turbulence, gravity waves

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JMS023 **Oral Presentation** **1380**

Nonlinear numerical simulation investigation of generalized Rayleigh-Taylor instability on the development of pre-midnight plume event during geomagnetic storm

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D. Chakrabarty

In order to understand equatorial spread F (ESF) phenomenon, a non-linear numerical simulation model was developed by solving a set of plasma fluid equations that describe the generalized Rayleigh-Taylor instability (GRT). This model has been used to investigate the dependence of different background conditions during magnetically quite time to understand the bottomside confinements, topside electron density control, importance of multiple-mode seeding of ESF etc. In the present work, the role of storm-time electric fields during pre-midnight hours is investigated based on the developments of ESF as observed by Indian MST radar at Gadanki (13.5oN, 79.2oE, dip lat 6.3oN) during two prompt penetration events associated with geomagnetic storms. In one of the events, ESF was found to be absent as the oscillating penetration electric field was westward over the equator till 2130 LT. In that case, the subsequent alteration of electric field to eastward for almost 2000s did not assist in the development of pre-midnight plume event. In another event, as the alteration brought forth by the storm changed the polarity of zonal electric field into eastward, the development of ESF was observed around 2030 LT. The electric field on that night became westward around 2100 LT and changed the polarity to eastward once again at 2130 hr that remained eastward for about 2000s similar to the previous case. This led to the development of a plume event during pre-midnight hours. The present modeling investigation revealed that the storm induced eastward electric field is a necessary condition but not a sufficient condition for the development of pre-midnight plume structure if the base of the F region is lower than 350 km as is the case, in general, during nighttime hours. A pre-seed of a significant amount of perturbation amplitude in the altitude range of 300-370 km is found to be required for the development of pre-midnight plume structure. The confined ESF irregularities developed in the post-evening hours are suggested to provide such seed perturbations. The importance of pre-seed in explaining the occurrence variability of ESF plume observed during disturbed period will be highlighted in the presentation. The uncertainty in quantifying the amplitude of perturbation will also be discussed.

Keywords: numerical simulation, rayleigh taylor instability, equatorial spread f

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JMS023 **Oral Presentation** **1381**

Kelvin-Helmholtz instability at the Earths magnetopause: Characteristics and recent advances

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Kelvin-Helmholtz (KH) or wind-over-water instability can develop at velocity shear layers, and hence is a ubiquitous phenomenon. Universal consequences of this instability are momentum transport and intrusion of matters from one side of the shear layer to the other, when it grows nonlinearly to form rolled-up vortices. It was suggested several decades ago that the KH instability excited at the magnetopause, the boundary between the solar wind and the magnetosphere, drives global convection of plasma in the magnetosphere (momentum transport). On the other hand, since plasmas surrounding the magnetopause are collisionless, in contrast to the atmospheric and ionospheric particles which collide frequently with each other and whose mixing is facilitated by KH vortices, it had been unclear if the KH instability plays a role in mass (plasma) transport across the magnetopause. We present recent simulation studies showing how plasma transport can occur through the KH instability, and also in-situ observations by spacecraft consistent with the theoretical expectation. We, in particular, emphasize unique roles of the magnetic field, whose tension acts as a stabilizing force like surface tension on one hand, but which on the other hand induces in vortices secondary plasma instabilities, such as magnetic reconnection, crucial for the mass transport, in a high beta (plasma to magnetic pressure ratio) plasma as seen at the magnetopause. Some remarks on energy transport from the magnetopause region to the ionosphere that can be achieved via magnetic field-aligned current or Alfven wave generated through the KH instability and on their relation to aurora are also given.

Keywords: kelvin helmholtz instability, magnetopause, transport

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JMS023 **Oral Presentation** **1382**

About the ion acceleration in F layer of the ionosphere

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We have investigated the occurrence of the accelerated ions in F layer of the ionosphere by the quasilinear theory.The ion beams are arisen as the result of the ion two-dimensional diffusion in the region of Alfven turbulence. The trigger mechanism of the phenomenon is the stratification of the magnetospheric convection due to a friction of the convective flow of the plasma about the ionosphere. On the other hand the energetic ions flowing out from the ionosphere give the contribution to the magnetospheric plasma, their energization and transport mechanisms.

Keywords: ion, beams, convection

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JMS023 **Oral Presentation** **1383**

ULF doppler oscillations in the low latitude ionosphere

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Colin Waters, Ian Dunlop

An array of magnetometers and Doppler sounders spanning L=1.56 - 2.77 was used to examine perturbations in the daytime ionosphere driven by downgoing daytime Pc3-4 ULF waves. For frequencies away from the local field line resonance (FLR), the waves drive mostly vertical motions of the F-region plasma with an amplitude of order 0.03 - 0.06 Hz/nT, and impose a phase delay of 30o to 40o to the downgoing wave. At the local resonant frequency and harmonics the amplitude and phase shift increase markedly. We modeled this with a boundary value approach allowing an admixture of ULF wave modes and oblique magnetic field geometry, and using actual ionospheric parameters. The model results agree well with observations when the downgoing wave mode is varied smoothly from pure fast mode away from the resonance to mostly transverse mode at resonance. These results provide new information on the interaction between downgoing ULF waves and the ionospheric plasma.

Keywords: perturbations, plasmawaves

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JMS023 **Oral Presentation** **1384**

Neutral instabilities in the lower and upper atmosphere: similarities in dynamics and effects

Prof. Miguel Larsen
Dept of Physics Clemson University

The talk will focus on similarities between conditions in the mesosphere-lower-thermosphere (MLT) region and the transition from the planetary boundary layer to the more stable atmosphere above the friction layer. In particular, it will be shown that the background wind profiles often have similar stability characteristics in both regions and that there are similarities in the static stability profiles as well. Shear instabilities are known to be important in both regions. The important role of the Kelvin-Helmholtz instability is not surprising, but there is also evidence that instabilities that are typically only associated with the boundary layer, such as convective roll instabilities, are active and may play an important role in the MLT region. The observational data relevant to the stability of the MLT transition region will be summarized and evidence for the occurrence of instabilities in that region will be discussed.

Keywords: instabilities, neutral shears, mesosphere lower thermosphere

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JMS023 **Oral Presentation** **1385**

Radar and optical observations of instabilities related to the aurora

Prof. Joshua Semeter
IAGA

Coupling between the solar wind and the magnetosphere generates significant free energy in the magnetospheric plasma. This free energy, manifested in the form of particle beams, electrical currents, and anisotropic particle distributions, provides a source for the rich taxonomy of instabilities observed throughout the magnetosphere. In many cases, these instabilities produce effects which are readily observed using ground-based radar and optical diagnostics. Examples include spatio-temporal morphologies in auroral video, and perturbations to plasma state parameters observed by incoherent scatter radar. Ground-based sensors are critical in the study of magnetospheric dynamics because they provide time-dependent information in an Earth-fixed reference framea perspective not possible from an orbiting platform. In this talk I will review radar and optical observations related to instabilities and non-MHD processes in the auroral magnetosphere.

Keywords: aurora, magnetosphere, ionosphere

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JMS023 **Poster presentation** **1386**

The occurrences of ionosonde spread F and GPS phase fluctuations in Taiwan

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Fang-Dar Chu, Jann-Yenq Liu

This study presents the occurrences of the ionosonde spread F and GPS phase fluctuations in equatorial ionization anomaly (EIA) crest for different solar activity. The observation instruments, ionsonde and GPS receivers, are setup at north of Taiwan. The observation was took from 1994 to 2000 when solar activity was changed from minimum to maximum. The spread F is categorized into range spread F (RSF) and frequency spread F (FSF) two types, and the GPS phase fluctuations are divided into three different levels to represent the strength of irregularities. The annual and nocturnal occurrence variations for two observations in each year are examined.

Keywords: spread f, gps phase fluctuations, eia

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JMS023 **Poster presentation** **1387**

GPS signal scintillation in a disturbance magnetic period over Brazilian territory

Mrs. Lilian Moor
IAMAS

Henrique Carlotto Aveiro, Tiago Jaskulski, Juliano Moro, Eurico Rodrigues De Paula, Clezio Marcos Denardini

At the Brazilian low latitude ionosphere the ionospheric irregularities (bubbles) occur from September through March after sunset and in the sunset-midnight time sector during magnetically quiet time periods. The bubbles present also dependency with the solar flux and latitude. These plasma irregularities cause amplitude and phase scintillations in the GPS signal and can cause degradation in the GPS navigational accuracy due to losses of lock in the GPS satellite signals. However during magnetically disturbed periods this scintillation pattern can change and irregularities can be also observed during April to August and even during the post-midnight time sector. In this work we present the effects of four magnetic storms over the ionosphere using data from 4 GPS receivers that monitor the signal of GPS satellites in the L1 band. We used data from one Brazilian GPS stations located at the So Martinho da Serra, Southern Space Observatory SSO/CRS/INPE (29.28 S, 53.82 W, dip lat. 18,57 S), and compare its data with the data from three others INPEs stations located at So Lus (2.33 S, 44.21 W, dip lat. 1.73 S), So Jos dos Campos (23.07 S, 45.86 W, dip lat.18,01 S) and Cuiab (15.45 S, 56.07 W, dip lat. 6.56 S). The Dst and Kp magnetic indices were used to select the storm periods. Examples of plasma irregularity triggering and inhibitions due to magnetic storms are presented and the physical mechanisms responsible for such anomalous behavior are discussed.

Keywords: ionosphere, instabilities, gps

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JMS024 **1388 - 1449**

Symposium
Data Assimilation for the Atmosphere, Ocean and Land Surface

Convener : Dr. Richard Swinbank
Co-Convener : Prof. Mu Mu

Data Assimilation is a key technique in Earth Science, allowing the exploitation of the vast quantity of measurements of the atmosphere, ocean and land surface. We are living a golden age in which a wide range of data from research satellites, such as EOS-Aura, COSMIC and CloudSat, complements the increasing amount of data from operational weather satellites. Data assimilation can organise the wealth of data from both satellite and in situ platforms to analyse the current state of the Earth System and form the basis of improved forecasts from the meso to the global scale. The session will bring together scientists working across a broad range of subject areas; particular areas will include: - novel assimilation methods, - weather and climate prediction, - mesoscale and cloud-scale processes, - atmospheric chemistry, - oceanography, - land surface and hydrology

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JMS024 **Oral Presentation** **1388**

Data Assimilation of Vertical Normal Modes with AMIC

Prof. Martin Ehrendorfer
IAMAS

Ronald M. Errico

Results from data assimilation experiments are presented that perform analysis steps being restricted to correcting vertical normal modes. Such a procedure mimics to some extent improvements in analysis accuracy achievable if only certain observation types (e.g., surface pressure) are available, or if certain (barotropic or baroclinic) vertical structures are strongly emphasized by the background error statistics. These assimilation experiments are carried out within the framework of the intermediate-complexity model AMIC (Atmospheric Model of Intermediate Complexity). AMIC is a horizontally spectral model (using resolutions T45 or T106) with six or nine levels in the vertical describing the dynamics of the quasigeostrophic potential vorticity equation. Through appropriate forcing AMIC reflects several properties of the atmosphere, auch as time scales, dynamics, and error growth behavior, to a reasonably satisfactory degree. Data assimilation experimentation with AMIC is also facilitated as this model contains a complete tangent-linear and adjoint package. Preliminary results from these assimilation experiments will be presented, such as the influence on the analysis itself, the impact on subsequent forecast error, as well as on the mutual interaction between different vertical modes during the short-term forecast period over which the non-modal nature of growing errors is important. Preliminary results suggest that correction of the barotropic mode may already substantially improve analysis accuracy.

Keywords: vertical normal modes, intermediate complexity model, nonmodal error growth

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JMS024 **Oral Presentation** **1389**

Dressing Ensemble Kalman Filter using Hybrid Coordinate Ocean Model in Pacific

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State Oceanic Administration, China National Marine Environmental Forecasting Center

Jiang Zhu

Computation cost required by the ensemble Kalman filter (EnKF) is much larger than that of some simpler assimilation schemes, such as the optimal interpolation (OI), the three dimension variational method (3DVAR). This limits its applications when the computation cost is a primary concern. As a result, the ensemble optimal interpolation (EnOI), a crudely simplified implementation of the EnKF sometimes is used as a substitute in some oceanic applications. The EnOI requires much less computation time than that of the EnKF. However, EnOI uses only a stationary forecast covariance that is based on a set of snapshots taken from a model long run. In this paper, to compromise the computation cost and the dynamic covariance, we use the idea of dressing a small size dynamical ensemble with a larger number of static ensembles in order to form an approximate dynamic covariance. This idea requires much less computational burden than EnKF. The term dressing means that a dynamical ensemble seed from model runs, is pertubated by adding the anomalies of some static ensembles. This dressing EnKF (DrEnKF for short) scheme is tested in assimilating real altimetry data in the Pacific using Hybrid Coordinate Ocean Model (HYCOM) over a four-year period. The size of the dynamical ensemble seeds is 10 and the static ensemble is 100 that are taken from a long run of the model. Each seed is dressed by 10 static ensembles. Results are compared to an EnKF assimilation run that uses 100 dynamical ensembles. Both temperature and salinity fields from the DrEnKF and the EnKF are compared to observations from Argo floats and the OISST dataset. The results show that the DrEnKF and the EnKF almost yield the similar root mean square errors (RMSE) at every model levels. Error covariance matrices from the DrEnKF and the EnKF are also compared and show good agreement.

Keywords: dressing, enkf, hycom

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JMS024 **Oral Presentation** **1390**

Balanced Multivariate Model Error in the Ensemble Kalman Filter Data Assimilation

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Fei Zheng, Rong-Hua Zhang

Ensemble Kalman filter (EnKF) depends on a set of ensemble forecasts to calculate the background error covariance. Without model perturbations and inflation of forecast ensembles, the spread of the ensemble forecasts will soon collapse. There are several ways to generate model perturbations, i.e., perturbations on model parameters/parameterizations, perturbations on models forcing fields and adding some model error terms to the right-hand-side of the model equations. In this presentation, we focused on the adding model error terms approach. This approach is convenient for those unforced models, such as coupled atmosphere-ocean models. It usually utilizes a first-order Makov chain model for modeling model errors. Using an intermediate coupled model for ENSO prediction, we demonstrate that it is necessary to develop balanced, multivariate Makov-chain models in order to successfully assimilate both sea surface temperature (SST) and sea surface height (SSH) observations. A simple, general approach to build a balanced, multivariate, Makov-chain based model error model is proposed. With different model error models (univariate, unbalanced multivariate and balanced multivariate), EnKF data assimilation experiments using realistic SST and SSH observations are performed to show the impacts of the balanced multivariate model error model. A new initialization scheme for ENSO ensemble forecast is built based on the proposed data assimilation scheme and leads to substantial improvement on ENSO prediction skills via successfully assimilating SST and SSH observations.

Keywords: data assimilation, enkf, enso

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JMS024 **Oral Presentation** **1391**

Data Assimilation: end-to-end application to research satellite data

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Research satellite data are a valuable but expensive resource to study and monitor the Earth System. Thus, it is important that the best possible use is made of this resource, end-to-end in the mission: from pre-launch mission planning to post-launch value-adding activities. This presentation argues, in general and with specific examples, that space agencies should position data assimilation at the centre of their satellite activities, using it for the objective evaluation of the incremental value of future satellites, the objective evaluation of current satellites, and for adding value to the satellite data by combining their information with that of Earth System models.

Keywords: data assimilation, research satellites, end to end

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JMS024 **Oral Presentation** **1392**

Reconstruction of sulphur dioxide emissions using ensemble filter and smoother

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Arnold Heemink, Martijn Schaap

Fine particulate matter (aerosols) is relevant for human health and its components are associated with climate effects. Large uncertainties in emissions, formation routes and sinks of these particles cause that model performances for particulate matter and its components are relatively poor. We are developing a system to assimilate observed particulate mass concentrations within a regional chemistry transport model. Presently, our focus is on the component for which enough information is available: sulphate. In our study the focus is on the real life application using the chemistry transport model LOTOS-EUROS to simulate the air pollutant concentrations over Europe. We give an overview of our modeling system. The measurements of sulphur dioxide and sulphate are derived from the EMEP network in a set of 48 ground-based stations in Europe for the year 2003. A part of them is used for the assimilation and the other only for validation of results. Different data assimilation schemes have been used in air pollution applications. Ensemble-based assimilation is easy to implement, suitable for real-time estimation of concentrations and allows a general statistical description. The ensemble Kalman filter, one of the Monte Carlo sequential methods, is used to improve the estimation of the assimilated concentrations of sulfate and to reduce the uncertainties in the sulfur emissions. The assimilation results depend on the model and the parameters involved in the process, eg., the number of observation, the accuracy of algorithms, and the noise specification. We will present the setup and results of assimilation experiments which prove the feasibility of ensemble-based algorithms to reconstruct the pollutant emissions and concentrations.

Keywords: ensemble, filtering, smoothing

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JMS024 **Oral Presentation** **1393**

Late 20th-century global warming: Lessons from a 'poor man's assimilation' of radiosonde temperature data since 1959

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Cathryn Meyer

Temperature trends are presented from a new homogenization of the global atmospheric temperature record since 1959 from 531 radiosonde stations. An objective methodology was used bearing some resemblance to traditional data assimilation techniques, in the sense that the data were projected onto a model of both the natural variability and errors, except that the method is iterative and is designed to produce unbiased estimates of means and climate signals. We obtain tropospheric temperature trends that appear much more realistic than those obtained in previous efforts to homogenize the data, including one employing the ECMWF data assimilation system (Haimburger 2005) and previous (unhomogenized) reanalyses. This is because previously employed methods, especially traditional data assimilation methods, are not properly designed to produce unbiased estimates in the presence of heterogeneous sampling and measurement errors. Successes, limitations, and lessons of the new method are discussed, as are the implications for the next generation of reanalyses and possible utility of our method in creating initial guess fields for subsequent refinement by more traditional approaches.

Keywords: climate change, data analysis, lapse rate

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JMS024 **Oral Presentation** **1394**

Recent Developments of the Maximum Likelihood Ensemble Filter (MLEF): Non-differentiable Framework and Other Applications

Dr. Milija Zupanski
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Dusanka Zupanski

The Maximum Likelihood Ensemble Filter (MLEF) is a control theory based ensemble data assimilation system. The MLEF includes components of variational data assimilation (i.e. the cost-function minimization), and of the ensemble Kalman filters (i.e. the use of ensembles in transporting the uncertainty in time). Depending on the complexity of the numerical model and the number of the degrees of freedom in the system the MLEF can be used as a full or a reduced rank ensemble data assimilation method. The analysis step of the MLEF will be presented as a non-linear and non-differentiable minimization algorithm. The similarity and differences between the MLEF, variational, and ensemble Kalman filtering methods will be also discussed. The MLEF has been used in variety of applications encompassing the scales ranging from the microscale to global scales. Some of the numerical models employed in the past include: NASA GEOS-5 column model, Colorado State University shallow-water model, NCEP Global Forecasting System model, RAMS non-hydrostatic model, NASA Goddard Cumulus Ensemble cloud-resolving model, etc. Recent results using these and other models with MLEF will be shown.

Keywords: ensemble, non differentiable, variational

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JMS024 **Oral Presentation** **1395**

Assimilation of precipitation in NASA GEOS5-DAS using model as a weak constraint

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Arthur Hou, Xin Lin

Assimilation of precipitation in a global modeling system poses a special challenge in that the observation operators for precipitation processes are based on parameterized physics. The model errors in the parameterization must be rectified in order to make effective use of precipitation information. In this work we report the development of a variational algorithm that uses model physics as a weak constraint to assimilate precipitation observations in NASA's global data assimilation system (GEOS-5 DAS). The implementation takes a two-step approach. In the first step within a 1D variational continuous assimilation framework, satellite observations of precipitations are assimilated to estimate the errors in model's moisture tendencies. In the second step these tendency corrections are applied to the 4D assimilation in the same analysis time window to obtain dynamically consistent reanalysis of atmospheric states. The monthly assimilation statistics show that this assimilation approach effectively acts as an online estimation and correction of forecast model errors associated with precipitation processes. In addition to improving the global precipitation analysis, it also has a positive impact on physical variables related to precipitation by allowing the system to directly respond to the improved precipitation processes. The case study on hurricane Katrina shows that the assimilation of precipitation provides more realistic and accurate representation of the structure and strength of the hurricane in global analyses. The forecast skills for the hurricane also show higher scores of quantitative precipitation forecasts (QPF) and better storm trajectory.

Keywords: assimilation, precipitation

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JMS024 **Oral Presentation** **1396**

An Overview of Theoretical Aspects of Data Assimilation

Dr. Olivier Talagrand
IAMAS

Laurent Descamps

The purpose of data assimilation can be described as being to reconstruct as accurately as possible the state of the atmospheric or oceanic flow, using all available relevant information. That information essentially consists of the observations proper, and of the physical laws governing the flow, available in practice in the form of a discretized numerical model. Any piece of information will always be affected with some uncertainty, which can be described by a probability distribution. A convenient conceptual framework for assimilation is therefore bayesian estimation, which aims at determining the probability distribution for the state of the system, conditioned to the available information. Most present algorithms for data assimilation can be described as more or less empirical extensions of statistical least-squares linear estimation, which achieves bayesian estimation in the linear and gaussian case, to moderately nonlinear situations. As is well known, two broad classes of algorithms exist in that general framework. In sequential assimilation, which assumes the form of Kalman filtering in the linear case, the observations are introduced successively in one integration of the assimilating model. In variational assimilation, the model is globally adjusted to observations distributed over a time window. Variational assimilation requires repeated integrations of the adjoint of the assimilating model. Either approach has its own advantages and disadvantages, which are briefly discussed. Most of the research done at present on the theoretical aspects of assimilation bears on two aspects : how to evaluate and take onto account the errors in the assimilating model, and how to introduce nonlinearity and nongaussianity. Concerning nonlinearity, sequential ensemble assimilation, in which an ensemble of states is integrated in parallel, eliminates any need for a linearity hypothesis in the dynamics of the system. The updating of the ensemble elements with new observations is still most often linear and gaussian. And unpleasant sampling problems occur in the updating phase. Nonlinear and nongaussian algorithms exist in the form of so-called particle filters, but are too costly at present for large dimension applications. Concerning variational assimilation, nonlinearity can be dealt with through Quasi-Static Variational Assimilation, in which the length of the assimilation window is progressively increased. Ensemble methods, which seem to be the only way to practically achieve bayesian estimation, look very promising. Active work is being done on the development of methods for ensemble variational assimilation. One important aspect of ensemble methods is the objective evaluation of the obtained ensembles as deors of the bayesian probability distribution.

Keywords: bayesian estimation, ensemble methods, nonlinearity

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JMS024 **Oral Presentation** **1397**

Assimilation of SCIAMACHY total column CO observations

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Ivanka Stajner, Steven Pawson, Michael Buchwitz, Iryna Khlystova, John Burrows

We present the results of the assimilation of SCIAMACHY total column CO observations using the GMAO 3D-VAR constituent assimilation system. The purpose of this investigation is to better understand the error characteristics of both the model and observations. Background error covariance tuning is carried out using MOZAIC aircraft and EPA ground observations. Error estimates provided with the retrievals are also evaluated, and initial results indicate that they are somewhat conservative. Forecast errors (Relative to MOZAIC) are found to be smallest when the estimated observation error standard deviation is reduced by a factor of 2. We also investigate the vertical structure of forecast and analysis errors, and their correlation to the presence of clouds. The error reduction resulting from the assimilation of Sciamachy observations is found to be greatest at pressures less than 850 mb.

Keywords: carbon cycle, constituents

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JMS024 **Oral Presentation** **1398**

Realistic assessment of model uncertainty under limited available data

Prof. Marina Erechtchoukova
Atkinson Faculty York University IAHS

Complexity of aquatic environmental systems and their temporal and spatial heterogeneity call for sophisticated methods of systems state analysis to support sustainable decisions. The advantage of data assimilation techniques which are aimed at melding observation data with simulation models to improve assessments of natural systems states and to generate forecasts is obvious. Realistic evaluation of the uncertainty of observation data and model results is an essential part of data assimilation procedure which determines its successful application. Uncertainty of observation data can be diminished or magnified while propagating through the model into model results. Resulting uncertainty has different sources and uncertainty of observation data is only one of them. In many case it is hard to separate the effect of a particular source of uncertainty from the other effects due to confoundings. However, it is important to insure that modeling results do not degrade the reliable information obtained from observations. Transformation of uncertainty from different sources in a simulation model undoubtedly depends on model structure and its mathematical properties. There are many tasks related to watershed hydrology and the assessment of aquatic environment that can be supported by the simulation models designed under cascading simulation framework. The framework consists of several modules which can be used separately or combined to imitate the dynamics of interesting state variables. Each module describes specific groups of processes, e.g., hydrological processes or hydrochemical and hydrobiological processes. Interactions of processes from different groups are modeled by passing simulation results from one module to another. Mathematical formulae and equations employed in the modules exhibit different properties that can play significant role in uncertainty propagation through the model and its transformation into resulting uncertainty. The paper discusses the way of realistic evaluation of the model uncertainty for the task of the quality assessment of the aquatic natural systems under limited available observation data.

Keywords: model uncertainty, aquatic systems, data assimilation

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JMS024 **Oral Presentation** **1399**

An Ensemble Kalman Filtering Approach for Regional Ocean Data Assimilation

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R & D AER, Inc., Lexington MA IAPSO

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The Estuarine and Coastal Ocean Model (ECOM) was coupled with a modern data assimilation method based on the Local Ensemble Transform Kalman Filter (LETKF) and a series of simulation experiments was conducted. In these experiments a long ECOM run is taken to be the truth. Observations are generated at analysis times by sampling the nature run at model grid points with a specified density of observation, and perturbing these values with unbiased normally distributed random errors with specified standard deviations. A diverse collection of previous model states is used for the initial ensemble. All experiments use the same external forcing fieldstides, inflows at open lateral boundaries and from fresh water sources, and fluxes of momentum, heat, and moisture at the surfaceas in the nature run. As a control, a free running forecast (FRF) is made from the initial ensemble mean to check the relative importance of external forcing vs. data assimilation on the analysis skill. In the data assimilation, ECOM advances the ensemble in time to provide a background for the analysis step. The analysis step optimally combines the observations and the background. Results of the assimilation cycle and the FRF are compared to nature to quantify the skill of each. The principal findings are that: 1. The assimilation quickly eliminates the domain averaged bias of the initial ensemble. 2. After just a few cycles, errors are greatly reduced by the assimilation. Analysis errors are smaller than observation errors, and much smaller than the errors of the FRF. 3. Different variables in the ocean model respond to the external forcing with different time scales. FRF temperature and salinity very slowly approach the truth, while current and surface height very quickly approach the truth. 4. The filter is robust, converging to the truth over a wide range of data coverage. 5. As data density increases all of ensemble spread, bias, and error standard deviation decrease. 6. As ensemble size increases ensemble spread increases and error standard deviation decreases. 7. Increases in the size of observation error have a small impact on the analysis accuracy (error standard deviation), but the ensemble spread increases as observation error increases.

Keywords: kalman filter, new york harbor, data assimilation

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JMS024 **Oral Presentation** **1400**

Sensitivity to local and remote forcing mechanisms in the California coastal region using an adjoint model approach

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The Northern and Central California coastal circulation is characterized by complex dynamics driven both by internal instability processes and by external and boundary factors such as wind forcing, open boundary conditions, steep bathymetry and coastline shape. Understanding the relative contribution of these factors has both a theoretical and a practical relevance. From the theoretical point of view, it is important to determine the main driving mechanisms as they are tightly connected to the dynamics. From the practical point of view, knowing the extent of the influence of local versus remote forcing (and the regions of major influence) is fundamental for planning observational strategies and for data assimilation purposes. For these reasons, we have used the adjoint model version of the Regional Ocean Modeling System (ROMS) to study the sensitivity of the central California circulation to different driving mechanisms. The adjoint model is particularly suitable for sensitivity analyses because it allows to determine how a certain metric, which is representative of a physical aspect of interest, evolves due to linear variations of the system variables, the external forcing, the initial state, and the open boundary conditions. We have defined and studied the sensitivity of a number of metrics that best represent the coastal upwelling processes and the energetics of the California Current System. The three-dimensional sensitivity fields have been mapped in order to investigate their spatial distribution, while more quantitative results have been obtained by comparing the various sensitivities in particular case-study regions. The results for a geographical area centered around Monterey Bay will be shown and discussed.

Keywords: adjoint sensitivities, coastal, modeling

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JMS024 **Oral Presentation** **1401**

Assimilation of ozone data from satellite instruments into global models

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Atmospheric ozone is a trace gas with important impacts on the biosphere, atmospheric structure, and climate. Stratospheric ozone layer shields the biosphere from solar ultraviolet radiation. In contrast, elevated ozone in the atmospheric boundary layer is harmful for human health. Absorption of solar radiation by ozone provides the heat source for the increase of temperature with altitude in the stratosphere. According to model simulations ozone impact on climate depends on the altitude of ozone changes. Assimilation of ozone data from instruments on NASAs Aura satellite and ESAs Envisat has provided insights into the distribution and evolution of ozone in the stratosphere and in the vicinity of the tropopause. The quality of assimilated ozone will be illustrated by comparison with independent data from ozone sondes, aircraft, and occultation instruments. These instruments provide high-quality, but sparse ozone measurements. The vertical resolution of limb sounding instruments has been most beneficial for advances in the representation of ozone in the lower stratosphere using data assimilation. Small horizontal footprints of advanced nadir sounders allow imaging of pollution from urban centers or biomass burning. Tropospheric ozone columns are being successfully estimated by assimilation of nadir and limb viewing satellite data into models. However, tropospheric ozone profiles, diurnal variability, and ozone in the boundary layer are not as well constrained by available satellite data. This talk will provide an overview of the progress in ozone assimilation at NASA's Global Modeling and Assimilation Office including: impacts of limb data, assimilation of ozone within a general circulation model, and inclusion of stratospheric and tropospheric chemistry parameterizations.

Keywords: ozone, satellite, assimilation

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JMS024 **Oral Presentation** **1402**

Ocean Instabilities Captured By Breeding on a Global Ocean Model

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Eugenia Kalnay, James Carton, Shu-Chih Yang

In this study, the breeding method has been implemented on a global ocean model for the first time in order to identify ocean instabilities of different timescales and diagnose their dynamic causes through energetics. The breeding method was first developed by Toth and Kalnay (1993) in order to isolate and identify the growing component of the analysis error in a meteorological model. Over the years, breeding has proved to be very robust in estimating the shape of growing errors in a full nonlinear atmospheric model. One very useful feature of the breeding method is that it can enable the isolation of both fast and slow growing instabilities. The ability of bred vectors (BVs) to isolate slower growing instabilities has been demonstrated in atmospheric models by Pea and Kalnay (2003) and in coupled models by Cai et al (2003) and Yang et al (2005), who obtained BVs of the coupled ocean-atmosphere ENSO instabilities. In our paper, we implement breeding on the GFDL Modular Ocean Model 2.b code (MOM2) driven by observed winds (Carton et al, 2004). We show that breeding is an effective method of isolating instabilities in a global ocean model and demonstrate how different types of instabilities can be identified by tuning the parameters of the breeding experiment. The bred vectors identify instabilities in several regions and seasons, such as the winter tropical instabilities at the northern edge of the cold tongue in the Pacific, and others in the Atlantic and Southern Oceans.Breeding facilitates the isolation of particular instabilities, but it does not allow us to identify the dynamic causes of those instabilities. In order to characterize the dynamic instabilities, we derive perturbation (bred vector) energy equations and present a diagnostic analysis of the instabilities based on these equations. Using these energy equations, we are able to analyze the barotropic and baroclinic components of tropical instability waves in the Pacific and Atlantic oceans, as well as investigate the causes of an instability off the coast of Argentina.

Keywords: breeding, instabilities, energetics

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JMS024 **Oral Presentation** **1403**

Recent developments of the local ensemble transform Kalman filter (LETKF) at JMA

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The local ensemble transform Kalman filter (LETKF) is an ensemble square root filter specifically designed to be efficient in the parallel architecture. LETKF is now under development with JMA (Japan Meteorological Agency)'s operational global and mesoscale models. In this presentation, recent progress of the developments, especially focusing on the experiments with the global model (known as the GSM), is presented. The LETKF has been implemented into the operational experimental system with the GSM at a TL159/L40 resolution, exactly the same version as the operational ensemble prediction system (EPS) as of February 2007. The LETKF is run in the same condition as the operational 4D-Var, with the same observation data input and quality control, which enables direct comparison between the LETKF and 4D-Var. Despite of the early stage of the development, the LETKF gives quite competitive performance in terms of computational time and analysis quality.

Keywords: data assimilation, ensemble kalman filter, numerical weather prediction

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JMS024 **Oral Presentation** **1404**

4D-VAR Assimilation of geostationary Seviri ozone measurements

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Ozone retrievals derived from SEVIRI infra-red measurements provide information on the ozone at the lower and middle stratosphere with the high temporal and spatial coverage typical for geostationary instruments. These ozone partial columns have been assimilated into the ECMWF NWP model using the ECMWF operational 4D-Var assimilation system. In this presentation the global ozone and wind fields resulting from assimilation of SEVIRI data are compared with results from a control experiment where SEVIRI data are only monitored. The possibility of indirectly improving the wind fields of the NWP model is discussed.

Keywords: ozone, stratosphere, 4d var

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JMS024 **Oral Presentation** **1405**

Land-atmosphere interactions in an high resolution atmospheric simulation coupled with a surface data assimilation scheme

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A correct modelling of the land-surface interactions can improve considerably the performances in numerical hydrological and meteorological models, in terms, respectively, of a more accurate water mass balance and surface forcing as lower boundary conditions for the atmosphere. Such mass-energy exchanges depend on the state of soil and vegetation at the surface. Their quantifications, in particular of the moisture flux (evapotranspiration), is of relevant importance also in agriculture (planning water managements, simulating ecological changes, etc.). A known weakness in atmospheric numerical models is constituted by a global parameterization of these surface processes with heavy simplifications. On the other side, more recent atmospheric models provide a better and more accurate modelization of the surface-atmosphere interactions, but they require a detailed parameterization, often difficult or impossible to be correctly. In this study sequences of satellite-derived estimates from SEVIRI sensors (aboard the Meteosat Second Generation) of land surface temperature (LST) are used as input in a data assimilation scheme in order to retrieve parameters that describe energy balance at the land surface. This assimilation procedure is coupled with the non hydrostatic limited area atmospheric model RAMS, in order to improve in the latter the accuracy of the energy and moisture budget simulation at the surface, replacing the lower boundary condition of the atmospheric domain. Coupling is realized using products of the assimilation procedure, in terms of energy fluxes and temperature and humidity surface states, inside the meteorological simulation. Comparison between meteorological simulation results with and without coupling with the assimilation scheme is discussed, both in terms of reconstruction of surface variables and of vertical profiles and Boundary Layer structure. In particular, the effects of the coupling on the moisture feedback between soil and atmosphere are considered. In order to evaluate the effects of the coupling on the rainfall events generation, the recycling ratio is also estimated both as scalar factor and as spatial distribution on the domain. The area of study is the Arno River Basin (8000 km2), in central , in a period of 4 months, from June to September 2005.

Keywords: data assimilation, surface interactions, recycling ratio

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JMS024 **Oral Presentation** **1406**

Model and Observation bias correction in altimeter ocean data assimilation in FOAM

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Prof. Keith Haines

We implement a combined online model and observation bias correction system in the UK Met Office FOAM (Unified Model) OI ocean data assimilation system. The observation bias scheme is designed to estimate the error in the mean dynamic topography that must be used for altimeter data assimilation. In future this mean dynamic topography and its errors may be calculated from GOCE geoid data. The mean dynamic topography field is added to the altimeter data supplied as sea-level anomalies giving the absolute sea surface height. The bias scheme separately estimates the remaining model bias in the model sea surface height field. The final unbiased estimate of the absolute dynamic topography is assimilated into the FOAM model by adjusting the subsurface density field using the Cooper and Haines scheme. Various diagnostics including the observation minus background statistics show that both model and observation bias correction schemes improve the assimilation results. Combining the schemes provides betterresults than either alone.

Keywords: assimilation, altimeter, bias

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JMS024 **Oral Presentation** **1407**

Efficient ways of introducing moist processes into the 4D-Var linear model

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In the last years 4D-Var assimilation systems have been introduced with great success at many operational centres. At the heart of these systems is a linear atmospheric model (and its adjoint) whose match with the full nonlinear NWP model is essential for the quality of the forecast.While the linearisation of a dry adiabatic model is to some extent straightforward, including moist processes into this linear NWP model is very challenging as they are usually strongly nonlinear. Particularly convection parametrisations are notorious for their unsteady behaviour which in combination with their nonlocal nature makes their direct linearisation very problematic and prone to large errors and even instabilities. Nevertheless, the strong impact of moist processes makes their inclusion a high priority task and some linear moist parametrisations have been developed at different centres. In this talk the Met Office's newly developed linear convection and large scale cloud parametrisations are presented. They are numerically very efficient (which is essential for their affordability) and at the same time have shown great benefit in forecast trials. These strong improvements of forecast skill are consistent with linearisation test runs which demonstrate that the match between linear and nonlinear model improves considerably when these linear parametrisations are employed.The linear cloud scheme is based on a quite general approximation which should be applicable to a large group of (prognostic and diagnostic) statistically based cloud parametrisations. This is a great advantage when applied in operational centres where the nonlinear parametrisations are subject to frequent improvements and alterations.The strongest forecast improvements are achieved by the linear convection parametrisation. Using several fields from the full nonlinear convection parametrisation as an input, the breakthrough in this work came through a statistical (time averaged) treatment which largely smooths the unsteady nature of these nonlinear input fields.So far this linear parametrisation considers only two of the leadingterms from the nonlinear scheme. The first, which describes the impact of the linearisation state mass flux on the assimilation increments, has a positive impact on the moisture field only (this is basically the term which was considered in the first parametrisation that was operational at ECMWF until last year). The benefit for the dynamical fields is entirely due to the second term which is related to perturbations of the CAPE closure

Keywords: 4d var, clouds, convection

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JMS024 **Oral Presentation** **1408**

Objectives of the THORPEX working group on data assimilation and observing strategies for high impact weather forecast improvements

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THORPEX: a Global Atmospheric Research Programme was established in 2003 by the Fourteenth World Meteorological Congress as a ten-year international research and development programme to accelerate improvements in the accuracy of high impact weather forecasts. THORPEX establishes a framework that addresses weather research and forecast problems whose solutions will be accelerated through international collaboration among academic institutions, operational forecast centres, and users of forecast products. One of the goals of THORPEX is to build an interactive forecasting system in which the uncertainty of the analysis and of future forecasts is assessed. This estimation leads to the development of a flow and situation dependent assimilation system. In particular, the use of targeted observations where and when extra information is crucially needed is envisaged. Enhancements to the observation usage in the "sensitive" regions of the atmospheric flow lead in turn to a reduction in forecast error. Major field experiments have been conducted and will continue to be organised, during which many ideas can be tested and new observations can be assimilated. The objectives of the working group on data assimilation and observation strategy are: to assess improvements in large scales by downscaling with a mesoscale model Tools developed in the community and data from field experiments could be used to investigate further these main issues. A broad participation to this group is welcome. Collaboration between academic researchers and weather centres is encouraged. This presentation will overview these objectives and relate those to the difficulties associated with using observations in operational data assimilation systems.

Keywords: thorpex, data assimilation

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JMS024 **Oral Presentation** **1409**

Assessment of the quality of the ozone measurements using data assimilation

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Space-based remote sensing instruments providing atmospheric measurements have different time and space resolution, vertical distribution and coverage. This makes the direct comparison of the measurements very difficult. Data assimilation has proven to be a far more powerful tool than simple interpolation techniques to create three-dimensional analysed fields for a given dataset. In the oral presentation, we will describe how the assimilation of ozone data from the several instruments (Odin/SMR, ENVISAT/MIPAS, ...) can be used to assess their precisions and biases against other ozone measuring instruments. To assess the quality of ozone retrievals against ozonesondes, TOMS and HALOE data, we use a three-dimensional variational assimilation scheme applied to the Mto-France MOCAGE chemistry transport model. The MOCAGE-PALM assimilation system has been already used by Mto-France and CERFACS to analyse the Envisat/MIPAS data for the ASSET inter-comparison exercise. We have further developed the configuration of this system to better account for the ozone profiles. This upgraded system is used to assimilate the ozone retrievals during the August 2003 -- November 2003 period and comparison are made with the other ozone measuring techniques.

Keywords: data assimilation, ozone, mipas smr

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JMS024 **Oral Presentation** **1410**

Background error statistics for a limited area model analysis: ensemble estimation and comparison with other simulation methods

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As an alternative to the NMC method, an ensemble approach has been investigated in order to sample the error covariances for a limited area 3D-Var data assimilation. Using perturbed observations and perturbed backgrounds as input to the assimilation scheme, an ensemble of perturbed ARPEGE global analyses has been generated. Starting from the ARPEGE global ensemble of perturbed analyses and forecasts, an ensemble of limited area states has then been obtained by running the operational ALADIN limited area system, in dynamical adaptation mode. The estimation of the error covariances for the 6-hour ALADIN forecast and for the ARPEGE analysis has been studied. These two fields may be combined in a generalized formulation of the ALADIN 3D-Var, in order to provide a limited area analysis that accounts both for the limited area background and for the available global analysis. The evolution of the dispersion spectra has been evaluated with respect to the effects of the successive steps of an ALADIN run: the ARPEGE analysis, the digital filter initialization and the ALADIN forecast. The differences between the ARPEGE and ALADIN fields, when the two models are subject roughly to the same initial state, have been studied too. These model differences can be related to some ARPEGE and ALADIN model errors (both with respect to the truth at the LAM resolution) and a decomposition of them is proposed in this way. Moreover, a possibility to adjust the respective variance spectra of the ARPEGE analysis and ALADIN background dispersions, based on the variance of the ARPEGE/ALADIN differences and its decomposition, has been explored. The ensemble approach has been compared with two variants of the NMC method. It was found that the ensemble results are intermediate between those of the standard and lagged NMC technics. The ensemble approach has appeared to be a good framework for the evaluation of the error statistics involved in the generalized formulation of the ALADIN 3D-Var: the influences of the analysis equation, of the implied initial and lateral uncertainties, and of the involved short ranges are represented in a more accurate way than in the two NMC methods.

Keywords: assimilation, error, ensemble

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JMS024 **Oral Presentation** **1411**

Interest of assimilating future Sea Surface Salinity measurements from SMOS and Aquarius missions in the Mercator Ocean operational systems

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Mercator Ocean is developing various operational ocean forecasting systems for GODAE (Global Ocean Data Assimilation Experiment), but also in the context of MERSEA (Marine Environment and Security for the European Area) integrated project. Different ocean forecasting systems are designed to simulate (1) the Atlantic and Mediterranean Sea (from 1/3 to 1/15), and (2) the global ocean circulation (from 2 to 1/4). An OSSE (Observing System Simulation Experiment) using different SSS products (Level 2 and Level 3) have been performed (i) to contribute to the development of the ground segment of the ESA SMOS (Soil Moisture and Ocean Salinity) mission, (ii) but also to quantify the benefits of assimilating SSS in ocean forecasting systems. This OSSE used the new generation of fully multivariate assimilation system referred to as SAM2v1 which is being developed from the SEEK (Singular Evolutive Extended Kalman) algorithm. This scheme is a Reduced Order Kalman Filter using a 3D multivariate modal decomposition of the forecast error covariance. In all assimilation experiments, the operational observation dataset (along track sea level anomalies, SST, temperature and salinity in situ profiles and T/S climatology field in under 2000 meter depth) have also been assimilated. Results of the OSSE enabled to show the positive impact of SSS assimilation on the MERCATOR operational forecasting system with a regional configuration at 1/3. Conclusions of this first SSS data assimilation experiments in an operational context will be shown and discussed.

Keywords: osse, sea surface salinity, ocean forecasting system

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JMS024 **Oral Presentation** **1412**

Extensions and Applications of the ECCO Near Real-Time Ocean Data Assimilation System

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Recent advancements and applications are described of the near real-time ocean data assimilation system of the consortium for "Estimating the Circulation and Climate of the Ocean" (ECCO). The assimilation system based on the Kalman filter and smoother provides estimates of the physical state of the ocean from 1993 to present that are extended regularly on a monthly basis. The estimates provide a means to monitor the state and evolution of the ocean, and are utilized to study ocean processes and their impact on the climate system. The estimates are being improved by expanding the suite of estimated variables (control space) and by incorporating recent advancements in modeling systems. The former includes estimations of diabatic errors and time-correlated uncertainties, in particular model biases. Estimates of different resolution are nested regionally to resolve small-scale model uncertainties simultaneously with larger-scale variabilities. Adjoints of different elements of the model are incorporated into the sequential estimation algorithm for improved accuracy and computational efficiency. The estimation system is also being ported to the ocean component of a coupled ocean-atmosphere model. These and other advancements will be described with examples and applications of the estimation system.

Keywords: ocean circulation, kalman filter, rts smoother

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JMS024 **Oral Presentation** **1413**

A four-dimensional data-assimilation system for the community WRF model for mesoscale data assimilation and forecasting

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Although 3/4DVAR-based data-assimilation approaches have been adopted by, and greatly benefited, global-scale and synoptic-scale NWP, their application to meso-beta and -gamma scale forecasts is limited. This is due to the fact that small-scale weather processes vary greatly in time and space, and that observations available for such scales are relatively sparse and are insufficient to define the local-scale circulations. In the last five years, NCAR, with collaborators, has developed a regional four-dimensional data assimilation (FDDA) and forecasting system based on a continuous "observation nudging" approach with the PSU/NCAR MM5 model. This approach is able to effectively combine the full-physics mesoscale models, the fine-scale underlying soil forcing, and all available synoptic and asynoptic observations, where the goal is to provide the best-possible analysis and short-term forecasts. Recently, this data-assimilation approach has been included in the community WRF system, for general use by the research community. In this paper, the design and major features of the WRF FDDA system are introduced. Work will be described regarding application of the system with a hybrid approach that combines the advantages of Newtonian-relaxation, 3DVAR, ensemble Kalman Filtering, and diabatic data assimilation that uses cloud and precipitation measurements.When running in a cycling mode, the WRF-FDDA system is capable of producing continuous four-dimensional synthetic weather analyses, and dynamically and diabatically "spun-up" initial conditions to startmodel forecasts. This is particularly beneficial for mesoscale weather prediction because one of the major goals of mesoscale NWP is to providemore accurate short-term, 0-12 h, forecasts of mesoscale circulationsand precipitation. It is known that 0-12 h forecasts that are"cold-started", as is the case with many global- and synoptic-scale forecasts from operational centers, suffer from spin-up issues.Applications to two extreme weather scenarios, summer severe convectionand hurricanes, are presented to illustrate the advantage of the WRFFDDA for these applications.

Keywords: mm5 wrf fdda, warm start 0 12h forecasts, convection and hurricane

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JMS024 **Oral Presentation** **1414**

Determining wind accuracy and resentativeness using high-resolution wind profiler and radiosonde data

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Summary: As series of evaluation studies have been conducted using a nearly one year long archives of Wind Profiler and high-resolution radiosonde data observed taken at the Oklahoma ARM-CART site. The objective of these studies is to determine: 1) the accuracy of Wind Profiler observations, 2) the spatial variability of all wind reports, and 3) the temporal variability of all wind reports. All three of these pieces of information are essential for the optimal use of these observations in future mesoscale data assimilation systems. Details: In the observation accuracy tests, six-minute frequency Profiler observations are matched in time and space with data from the radiosonde reports taken four times daily. Comparisons are made using radiosonde data within 25 km of the profiler location. Results show mid-tropospheric RMS vector differences of approximately 3 m/s, with larger differences nearer the earths surface and farther aloft. The RMS vector differences are similar for both the Low Mode and High Mode portions of the Profiler reports, even though the wind Bias changes significantly between the two reporting modes. Spatial variability can be approximated by varying the maximum radius using in for data comparison. By creating a series of cylindrical tubes of about 10-20 km thickness centered on the Wind Profiler site, the rate at which the RMS vector difference increases with radius can be calculated and then used to quantify the spatial variability of the wind data. Additional tests will assess whether this variability is a function of wind speed and how it changes with altitude. Temporal variability is determined by from the Wind Profiler data alone. In these tests, each of the high time-resolution Profiler reports is compared with data taken from 6 minutes to 6 hours from that time. The results show increases in temporal variability both with time and elevation, ranging from about 2.5 to greater than 4.5 m/s with elevation and reaching over 10 m/s at some levels over six hours. The results also show significant diurnal variations at both low and high levels. The combined spatial and temporal variability data were thencombined to determinenot only1) the Wind Profiler Instrument error, but also 2) the local atmospheric wind variability, and 3) the temporal and spatial change increases in variability at multiple layers of the atmosphere, for various times of day, and by season. Additional results will be shown at the formal presentation, including a discussion of additional quality control procedures that need to be employed when using the 6-minute Wind Profiler data retrospectively. As a results of this work, it is suggested that future data assimilation systems will be able to take optimal advantage of highly accurate wind data by considering not only the accuracy of the different sources of wind data, but also accounting for and differentiating between the observational errors and the error of representativeness using results such as these.

Keywords: wind profiler, representativeness, accuracy

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JMS024 **Oral Presentation** **1415**

Dynamically consistent decadal ocean/sea-ice estimates from a new-generation adjoint-based ECCO-GODAE global state estimation system

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Since the end of the 1990's the ECCO (Estimating the Circulation and Climate of the Ocean) Consortium has embarked on applying mathematically rigorous methods of state estimation and optimal control in the context of the global ocean circulation at decadal time scales. The method of Lagrange multipliers, implemented with an AD tool, is used to produce a least-squares fit of a general circulation model to as many observational data as is practical. While several ECCO solutions are in wide use the system is undergoing constant improvement in several directions: (1) model improvement, (2) model resolution, (3) injection of new data types and updates of existing observations, (4) improved a priori uncertainty estimates which define the quality of the solution, and interpretation of the residual model/data misfits in terms of remaining data, model and representation errors. The new ECCO-GODAE system is a result of progress in all these aspects, and has proved useful in addressing various science questions pertaining to decadal variability and requiring closed budgets. Here we focus on aspects (1) and (3). (ad 1): The system now comprises an atmospheric boundary-layer adjoint which permits the adjustment atmospheric state variables rather than air-sea fluxes through time, and corrects large imbalances in the NCEP/NCAR re-analysis products. The system now also includes a full Hibler-type thermodynamic/dynamic sea-ice model, thus providing an estimate of the sea-ice state. A major step is the move towards a truly global grid including the Arctic (topologically equivalent, but different in details to the "cubed-sphere" grid). (ad 3): At the present time the solution represents a misfit to about 410 million separate observational constraints including satellite altimetry and gravity, remotely-sensed SST and wind stress, ARGO profiles and conventional XBT, CTD and TOGA/TAO data. Newly added data include tide gauges, hydrographic data obtained from tagged seals as part of the SEaOS program which provide a wealth of data in the Southern Ocean, notably under the ice, and daily sea-ice concentration issued by the NSIDC.

Keywords: ocean state estimation, adjoint modelling, decadal variability

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JMS024 **Oral Presentation** **1416**

Development and validation of a chemical weather system at Environment Canada

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Cécilien Charette, Simon Chabrillat, Alain Robichaud, Yves Rochon, Yan Yang, Richard Mnard

In partnership with the European Space Agency (ESA) and the Belgium Institute for Space Aeronomy (BIRA-IASB), Environment Canada has developed an assimilation system for addressing chemical weather issues. It is based on the stratospheric extension of the operational weather prediction global model with a lid at 0.1 hPa. The model is coupled with a comprehensive on-line photochemical module to incorporate dynamical,radiative and photochemical interactions. In the stratosphere, TOVS-AMSU-a radiances and radiosondes observations are assimilated whereas MIPAS ocultation measurements are used for the assimilation of temperature and chemical constituents such as ozone, methane and nitric acid. Moreover, MIPAS temperatures have been used to calibrate the bias correction scheme of the AMSU-a stratospheric channels. Several data assimilation cycles throughout the period August-November 2003 have been performed for the validation of the different components of the system. Both 3D-Var and 4D-Var cycles have been performed to evaluate the impact of the assimilation methods on the results. In the case of 4D-Var cycles, the system uses long lived constituents from MIPAS as passive tracers in the tangent-linear and adjoint models for inferring wind increments in the lower stratosphere where wind observations are sparse. Analysis of the results will focus on the limitation of using a simplified chemistry in the incremental 4D-Var. The impact of radiative feedback from O3 and H2O on the model predictability has been investigated in different regions particularly over Antartica throughout the ozone hole event. Results have been validated against independent measurements such as ozonesondes, TOMS and HALOE. The study shows the capability of the assimilation system to produce comprehensive analyses of the meteorological fields and constituents.

Keywords: chemical, weather, system

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JMS024 **Oral Presentation** **1417**

Satellite data impact experiments in the Joint Center for Satellite Data Assimilation

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Much of the recent progress in skill of the operational numerical weather prediction systems can be attributed to new satellite sensors and to advances in the methodologies for assimilating the measurements obtained with these sensors. The Joint Center for Satellite Data Assimilation is playing a key role in accelerating and improving the use of the existing satellite data and in preparing for data from coming sensors in the operational assimilation community in the US. This talk will provide an overview of the various efforts toward this goal undertaken by the Joint Center and the partnering institutions within NASA, NOAA and the Department of Defense. The role of these experiments in helping to define the Global Observing system of the future will also be discussed.

Keywords: satellite, assimilation, impact

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JMS024 **Oral Presentation** **1418**

Changes in the Atlantic MOC estimated through the ECCO Synthesis Effort

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Armin Koehl

This paper will summarize ongoing ocean syntheses effort ongoing in Germany as part of the ECCO project (GECCO). Over the last decade, ocean data assimilation has made a remarkable progress, to the point that it is now feasible to perform mathematically rigorous global ocean data synthesis in a routine manner as a core strategy for climate research. In analogy to atmospheric re-analysis, this effort sometimes is referred to as reanalysis. However, in the absence of analyses in the ocean, the term data synthesis seems more appropriate. The GECCO estimate of the time-varying ocean circulation over the 50-year period 1952-2001 is analysed here with respect to decadal and longer term changes of the meridional overturning circulation (MOC) of the North Atlantic. The GECCO synthesis combines most of the data set available during the entire estimation period with the ECCO/MIT ocean circulation model using its adjoint over the entire period. In contrast to their study, however, but consistent with the hypothesis of a relation between the strengths of the MOC and the amplitude of the NAO index, our dynamically consisten syntheses reveals a general increase in MOC strength over the last 50 years. At most subpolar latitudes, changes in the models MOC strengths on decadal and longer time scale appear to be dominated by the southward communication of density anomalies along the western boundary originating from the subpolar North Atlantic. Accordingly, the most important cause for decadal MOC changes lies in the density variability of the Denmark Strait overflow water. Other potentially important mechanism, including watermass formation and convection in the Labrador Sea, local Ekman transport and westward propagation of Rossby waves along the baroclinically unstable southern edge of the subtropical gyre, appear less important in our solutions on those long time scales.

Keywords: changes, atlantic moc, ecco synthesis effort

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JMS024 **Oral Presentation** **1419**

Land Surface Data Assimilation

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Accurate initialization of land surface water and energy stores is critical in environmental prediction because of their regulation of land-atmosphere fluxes over a variety of time scales. Errors in land surface forcing and parameterization accumulate in these integrated land stores leading to incorrect surface water and energy partitioning. However, many new land surface observations are becoming available that may be used to constrain the dynamics of land surface states. These constraints can be imposed by (1) forcing the land surface primarily by observations, thereby avoiding the often severe numerical weather prediction biases, and (2) using data assimilation techniques to constrain unrealistic storage dynamics. Significant progress has been made in land-surface observation and modeling at a wide range of scales. Projects such as the International Satellite Land Surface Climatology Project (ISLSCP), the Global Soil Wetness Project (GSWP), and the GEWEX Continental-Scale International Project (GCIP), among others have paved the way for the development of an operational land data assimilation. Several of these systems have been implemented in near real time and at high spatial resolution for North American, European, and global domains. They are forced with real time output from numerical prediction models, satellite data, and radar precipitation measurements, and can incorporate land state observations as a constraint to the model dynamics using hydrologic data assimilation methods. Results of assimilation of land surface temperature, moisture, and snow are showing great promise to improve predictability and understanding of model realism. Because of its importance, and our increasing ability to observe relevant land surface information remotely, it is expected that the amount of hydrologic and land surface remote sensing data will grow exponentially over the next decade. However, its usefulness will be limited by our ability to analyze and integrate this diverse information with land models. Quantifying land process variability will require innovative interpretation of potentially large observation volumes, due to observation type, scale, and error disparities. The effect of variations in instrument type, placement, calibration and accuracy of both remote sensing and in-situ observations must also be quantified. The complexities of future land surface observation scenarios will require systematic methods to organize and comprehend this information. Therefore a comprehensive land surface data assimilation framework will be a critical component of future terrestrial observation and modeling systems.

Keywords: land surface, data assimilation

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JMS024 **Poster presentation** **1420**

A modified Ensemble Kalman Filter (EnKF) for data Assimilation in Coastal natomy of a Hydrological Model: A case study of the Athi and Tana River Basins

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A modified EnKF is presented for reconstructing historical rainfall from few observation sites within the Athi-Tana river basins (coastal Kenya). The ensemble Kalman filter (EnKF) is a 4-dimensional data-assimilation method that uses a Monte-Carlo ensemble of short-range forecasts to estimate the covariances of the forecast error. Using observed data from only six locations as input parameters in the EnKF algorithm, both spatial and temporal distribution of the hydrologic state is estimated for the whole basin. As it will be shown, previous and current observation is obtained and blended to form a better estimate possible. Indeed, the model falls within the range of actual values. In view of the EnKF flexibility, an application with numerical models can now be envisioned.

Keywords: wetlands, assimilation, kalmanfilter

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JMS024 **Poster presentation** **1421**

Data Assimilation for Ice Services

Mr. Tom Carrieres
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The International Ice Chart Working Group is an organization representing the operational ice services for many northern countries. An important initiative for IICWG is to migrate chart production from a largely manual process to a system more similar to weather prediction. In this scenario, numerical models will provide large scale automated products allowing human analysts to focus on critical areas of operational concern. This poster will review the models, data assimilation techniques and observations that are under development and identify key achievements. A work plan idicating participants, new directions and planned outcomes will also be presented.

Keywords: sea ice, data assimilation, prediction

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JMS024 **Poster presentation** **1422**

1-D ice cloud microphysics data assimilation system (IMDAS) development for retrieving cloud parameters by using AMSR-E satellite data

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Toshio Koike, Kun Yang, Tobias Graf

1D Variational (1D-Var) Ice Cloud Microphysics Data Assimilation System (IMDAS) is developed for retrieving reasonable cloud distributions. The general framework of IMDAS includes the Lin ice cloud microphysics scheme as a model operator, a 4-stream fast microwave radiative transfer model (RTM) in the atmosphere as an observation operator, and a global minimization method known as Shuffled Complex Evolution (SCE). The IMDAS assimilates the satellite microwave radiometer data set of Advanced Microwave Scanning Radiometer (AMSR-E) and retrieves integrated water vapor (IWV) and integrated cloud liquid water content (ICLWC). The retrieved IWV and ICLWC values are then used to construct the cloud profile according to the cloud base level and top level. This new method successfully introduces the heterogeneity into the initial state of the atmosphere, and the modeled microwave brightness temperatures agree well with observations of Wakasa Bay Experiment 2003 in Japan.

Keywords: data assimilation, cloud microphysics, cloud liquid water content

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JMS024 **Poster presentation** **1423**

Identification of the Rossby Waves at the Mid-Depth Tropical

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Argo float data (subsurface tracks and temperature profiles collected from March, 04 through May, 05) are used to detect signatures of long Rossby waves in velocity of the currents at 1000 m depth and temperature, between the ocean surface and 950 m, in the zonal band of 40N -240N in the Tropical North Atlantic. Different types of long Rossby waves (with the characteristic scales between 1000 km and 2500 km) are identified in the western [west of the Mid-Atlantic Ridge (MAR)] and eastern [east of the MAR] sub-basins. Along-shore wind fluctuations and an equatorially-forced coastal Kelvin wave were found to be responsible for the excitation of annual and semi-annual propagating Rossby waves in the eastern sub-basin. These waves are transmitted along a wave-guide formed by the African shelf and the MAR. The speed of their propagation varies in magnitude and direction due to bottom topography and irregularity of the coastline. Unstable standing Rossby waves with annual and semiannual periods are shown in both the sub-basins. All unstable waves, decaying, radiate shorter free Rossby waves propagating, both westward and northwestward, with speeds up to 10 cm/s. The standing Rossby waves are probably excited by the wind-driven Ekman pumping alone or in combination with linear and nonlinear resonance mechanisms. The additional analysis of subsurface float tracks from May, 05 through May, 06 supports the obtained results. References Chu, P.C., L.M. Ivanov, T.M. Margolina, T.P. Korzhova, and O.V. Melnichenko, Analysis of sparse and noisy ocean current data using flow decomposition. Part 1. Theory. Journal of Atmospheric and Oceanic Technology, 20, 478 - 491, 2003a. Chu, P.C., L.M. Ivanov, T.M. Margolina, T.P. Korzhova, and O.V. Melnichenko, Analysis of sparse and noisy ocean current data using flow decomposition. Part 2: Application to Eulerian and Lagrangian data. Journal of Atmospheric and Oceanic Technology, 20, 492-512, 2003b. Chu, P.C., L.M. Ivanov, O.M. Melnichenko, and N.C. Wells, 2007: On long baroclinic Rossby Waves in the tropical North Atlantic observed from profiling floats. Journal of Geophysical Research Oceans, in press.

Keywords: rossbywaves, osd, mid depth

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JMS024 **Poster presentation** **1424**

Disaggregating GRACE in a data assimilation system

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Matt Rodell, Rolf H. Reichle

We have developed a data assimilation system that introduces GRACE observations of terrestrial water storage anomaly (TWS) to the Catchment Land Surface Model (CLSM) using an Ensemble Kalman Filter (EnKF). Early results from the system were promising, as simulations with assimilation demonstrated increased skill relative to open loop at the scale of GRACE observation. The scale of GRACE observation, however, is quite coarse: monthly-averaged anomalies, with a spatial resolution of 160,000 km2 or less. Assimilation provided mixed results at sub-observation scale, indicating a need for informed disaggregation of the GRACE-derived anomaly. Here we present results from several efforts to distribute GRACE observations temporally and spatially in the context of an EnKF assimilation system. It was found that simple temporal disaggregation of monthly-average assimilation increments improved model realism with respect to groundwater and runoff variability. Spatially, disaggregation was attempted by (1) rule-based application of increments, (2) scaling increments by parameters of surface hydrology, and (3) using interpolated gridded GRACE estimates of TWS rather than basin-average values. These experiments have resulted in a more optimal assimilation system for GRACE TWS, and it is anticipated that the methods will benefit other efforts to assimilate data of coarse resolution.

Keywords: grace, hydrology, assimilation

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JMS024 **Poster presentation** **1425**

Using a feedback approach to estimate and update the surface resistance term for evapotranspiration models.

Dr. Raoul Granger
IAHS

Correctly describing the evapotranspiration process is an important requirement in hydrological and meteorological modeling; the evaporative process plays a major role in the partitioning of both energy and water at the surface. Most operational and predictive modeling systems use a form of the Penman (1948) equation as the basis for describing the evaporative process. The Penman equation was developed for saturated surfaces; however, while consistent with the principles of conservation of energy and aerodynamic relationships, it does not adequately describe the evaporation (and transpiration) which occurs from vegetation whose surface is not saturated. To extend the Penman equation to the non-saturated case, Monteith (1965) characterized the transfer of water vapor from an unsaturated leaf surface or soil using the concept of a stomatal or surface resistance, rs. Most predictive applications of the Penman-Monteith equation incorporate estimates of the resistance term that are based on laboratory-derived relationships between leaf water potential and parameters such as soil moisture, vegetation type, humidity, temperature and response to solar radiation. This introduces several additional data inputs and a degree of empiricism which reduces the appeal of the original Penman equation, with its simplicity and reliance on readily available data. Using evapotranspiration measurements obtained over a variety of natural vegetated surfaces, it is shown that the current formulations do not correctly represent the diurnal variation for the surface resistance, rs. A different approach, presented by Granger and Gray (1989), characterized the evaporation from a non-saturated surface using the ratio of the actual evaporation to the evaporation rate that would occur if the surface were saturated at the same temperature. Using a feed- back relationship, this relative evaporation, G, is related to the dimensionless relative drying power, D. This approach, known as the G-D method, requires only the same data inputs as does the original Penman equation. The relationship is unique and independent of surface cover type. Since both approaches represent extensions of Penman to the non-saturated condition, there is an explicit relationship between the surface resistance, rs, and the relative evaporation, G. The nature of this relationship is developed and examined. The dimensionless relative evaporation, G, which is readily obtained from standard meteorological observations, can thus be used to derive of the surface resistance. A data assimilation approach can be used to update the surface resistance, rs: the state variables (temperature and vapour pressure) resulting from the energy balance calculations for time t are used to determine G and thus rs for time step t+1.

Keywords: evapotranspiration, surface resistance, modelling

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JMS024 **Poster presentation** **1426**

On the representation of vortical flow and gravity waves in numerical algorithms for regional barotropic primitive equations

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Ali Reza Mohebalhojeh

In quantitative and qualitative assessment of the numerical algorithms for barotropic primitive equations, comparison with the real atmosphere can not be used as the main criterion to determine the accuracy of the algorithms. This holds particularly for limited-area applications when boundary conditions add to the difficulties of determining the true solution. The complexity comes from a combination of the barotropic primitive model error, the numerical algorithm error, and errors in the way data are assimilated to the model. It is thus necessary to use ever increasingly our dynamical knowledge of the behavior of the solutions of the barotropic primitive, or shallow water, equations in the process of determining the accuracy of numerical algorithms. A useful approach here is to study balanced (vertical) and imbalanced (gravity waves) parts of the flows, and their interaction. In spite of the limitations faced when working with real-atmosphere data, such study can uncover some important information on the working of the algorithms. Having this objective in mind, the present paper is devoted to study of spatial-temporal behavior of balanced and imbalanced parts in three numerical algorithms for the regional barotropic primitive equation. The algorithms are: the potential enstrophy conserving Eulerian algorithm of Sadourny (1975), and two algorithms derived from Sadourny 's algorithm by simply changing the prognostic variables from momentum-geopotential height to (i) Rossby potential vorticity (PV), divergence, geopotential height, (ii) PV, divergence, and ageostrophic vorticity. In the later two algorithms, PV is solved by a standard semi-Lagrangian method using piecewise bicubic interpolation and the other prognostic variables are solved by the proper use of Sadourny algorithm for momentum components and geopotential height. Compared with the Eulerian algorithm of Sadourny, the PV-based algorithm shows a marked improvement in the representation of both balanced and imbalanced parts of the flow.

Keywords: barotropic primitive, potential vorticity, imbalanced part

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JMS024 **Poster presentation** **1427**

Simulated Eddy Energy sources from a model of the Northeast Pacific Ocean

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We examined the energy sources for eddy variability in the Northeast Pacific, focussing on the coasts of British Columbia and Alaska. Examination of model results obtained from prognostic eddy-admitting simulations showed significant deviations of both the mean state and eddy variability from observational estimates and therefore we present results obtained with a novel new form of data assimilation referred to as spectral nudging. Spectral nudging is distinguished from standard nudging by its ability to act only on specified frequency bands; in the present case, we nudge only the sub-annual variability on spatial scales of one hundred kilometers or more. By using this approach, the broad aspects of the models mean state are constrained to remain near climatological conditions while the simulated eddy field is determined solely by the model dynamics. Results show the tendency of the circulation to be both baroclinically and barotropically unstable in different regions and to differing degrees. The nudged simulation indicates that baroclinic instability is more important as an energy source for eddies along the British Columbia coast; however, the barotropic energy transfer is at least as important as the baroclinic transfer along the coast of Alaska. Further, although the overall energy transfer is from the mean state to the eddy field, there are regions, particularly within a narrow band along the coast of Alaska, where the transfer of energy is from the eddy field to the mean flow. Thus, at least when spectral nudging is used, the simulated eddies help maintain the mean state in these regions.

Keywords: pop, eddies

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JMS024 **Poster presentation** **1428**

Assessing the impact of observations on numerical weather forecasts using the adjoint of a data assimilation system

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Yanqiu Zhu

With the adjoint of a data assimilation system (forecast model plus analysis scheme), the impact of any or all assimilated observations on measures of forecast or analysis skill can be estimated accurately and efficiently. The approach is especially well suited for assessing the impact of hyper-spectral satellite instruments on numerical weather forecasts because it easily allows aggregation of results in terms of individual data types, channels or locations, all computed simultaneously based on a single pass of the adjoint system. The NASA Global Modeling and Assimilation Office (GMAO) has developed the adjoint of its GEOS-5 atmospheric data assimilation system, consisting of the GEOS-5 finite volume atmospheric model and Gridpoint Statistical Interpolation (GSI) analysis scheme developed at the National Centers for Environmental Prediction (NCEP). In this study, the impacts of various observing systems, including the Atmospheric Infrared Sounder (AIRS), are examined during July 2005 and January 2006. It is found that both conventional and satellite observations contribute significantly to the reduction of forecast errors, with asymmetries in the magnitudes of their impacts depending on the season and hemisphere. The impact of AIRS radiances varies significantly from channel to channel, with some channels, particularly those most sensitive to water vapor, actually degrading the forecast on average. The adjoint-based impact calculations are compared with results from standard observing system experiments (OSE). The two approaches are shown to provide unique, but complementary, information. The adjoint method not only provides a more surgical means of assessing the impact of arbitrary subsets of observations, but also reveals explicit redundancies and dependencies between observing system impacts as observations are added or removed. Understanding these dependencies poses a major challenge for optimizing the use of the current observational network and defining requirements for future observing systems.

Keywords: observation impact, data assimilation, adjoint

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JMS024 **Poster presentation** **1429**

Tropospheric ozone derived by AURA OMI and assimilated AURA MLS fields using the ECMWF 4D-VAR Assimilation system

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Ozone is an important trace gas in the troposphere. It is not directly emitted into the troposphere, but chemically produced by NOx, CO, CH4 and other hydrocarbon which are emitted in large quantities due to human activities. The enhanced production of ozone in the summer can cause photochemical smog and excessive amounts of ozone near the surface are toxic. Ozone changes in the troposphere have also a large impact on the tropospheric composition since ozone is a primary source of hydroxyl radicals, which are the detergents of the troposphere. Observations from space platforms offer the possibility of measuring the distribution of tropospheric ozone over large areas, and the study of the large scale temporal and spatial behaviour. The method of extracting information about the troposphere from satellite measurements by separating the stratospheric component from the total ozone measurements is referred to as the tropospheric ozone residual (TOR). Here we present the tropospheric ozone columns derived by subtracting the stratospheric ozone distribution from Aura OMI total ozone measurements. The stratospheric ozone distribution is calculated by using the ECMWF 4D-VAR assimilation system to produce analyses using both operational and Aura MLS ozone observations. Using this technique, we compare the derived tropospheric ozone columns with integrated tropospheric ozone columns from ozone sondes profiles and Aura TES profiles.

Keywords: tropospheric, ozone

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JMS024 **Poster presentation** **1430**

Impact of using a non-local quasi-phase operator in Assimilations of GPS Radio Occultation refractivity

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Jefferey Anderson, Ying-Hwa Kuo, Chris Snyder

In lower troposphere, the atmospheric refractivity may have large horizontal gradients due to the existence of fronts and variations associated with water vapor, especially within the tropics. In this study, a non-local quasi-phase observation operator is evaluated in the assimilation of CHAMP RO refractivity using a WRF ensemble assimilation system at 50km resolution. The non-local operator calculates the quasi-phase through integration of the model refractivity along the observed ray-paths. As a comparison, a local refractivity operator is also evaluated which calculates the model refractivity at the observed ray perigee points. The assimilation is done over North America during January 2003 in two different situations: in conjunction with dense, high quality radiosonde observations; with only satellite cloud drift wind observations. The analyses of water vapor and temperature are verified against nearby withheld radiosondes. The bias and RMS errors of the analyses using the non-local operator are significantly reduced in the troposphere, compared with those using the local operator when the only additional observations are satellite cloud drift winds. The impact of the non-local operator remains positive, but with reduced magnitude, when radiosonde observations are assimilated.

Keywords: ensemble data assimilation, radio, occultation

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JMS024 **Poster presentation** **1431**

Mesoscale EDDY structure in the Japan Sea estimated by CTD data assimilation

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Naoki Hirose, Tatsuro Watanabe

By assimilating satellite remote sensing data such as the sea surface height or temperature into an ocean circulation model, it is possible to estimate realistic water temperature and salinity structure and the velocity changes in the ocean interior. However, the present assimilation system is still imperfect to represent the fine scale variabilities. In this study, the in-situ CTD profiles are assimilated into RIAM Ocean Model, a three-dimensional Japan Sea (JS) circulation model. We investigate the effectiveness for assimilation of the CTD profiles only to represent the mesoscale variabilities in the JS by compared with the simulation and the sea surface height (SSH) assimilation results. The CTD profiles edited by Fisheries Research Agency are collected for the Japanese coastal area in 1999-2001. We apply an approximate Kalman filter that uses the reduced-order error covariance matrixes in space. By the use of Kalman filter, the sea surface dynamic heights estimated from the observed CTD profiles are assimilated into the JS model at each measurement point. As a consequence of the covariance matching, the estimated errors of the CTD data and the simulation were comparable, although the representation error that can not be described by the model physics is included in the data error. In the CTD assimilation result, the subsurface temperature structures associated with the mesoscale eddies were improved than the simulation or the SSH assimilation. The improvement of reproducibility of the physical structure was confirmed by assimilating CTD profiles, especially in the southern area of the JS where there are many mesoscale structures and polar front. The CTD data assimilation certainly improved the representation of the mesoscale features.

Keywords: ctd profile, mesoscale eddy, japan sea

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JMS024 **Poster presentation** **1432**

An equation- free, reduced-order modeling approach to Tropical Pacific simulation

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The equation-free (EF) method is often used in complex, multi-scale problems. In such cases it is necessary to know the closed form of the required evolution equations about macroscopic variables within some applied fields. Conceptually such equations exist, however, they are not available in closed form. The EF method can bypass this difficulty. This method can obtain macroscopic information by implementing models at a microscopic level. Given an initial macroscopic variable, through lifting we can obtain the associated microscopic variable, which may be evolved using Direct Numerical Simulations (DNS) and by restriction, we can obtain the necessary macroscopic information and the projective integration to obtain the desired quantities. In this paper we apply the EF POD-assisted method to the reduced modeling of a large-scale upper ocean circulation in the tropical Pacific domain. We discuss the convergence and accuracy of this method along with a series of numerical experiments that were carried in order to discuss some factors that affect the results. These factors include the number of snapshots, basis functions based on proper orthogonal decomposition (POD) mode and the ratio between large- and short-scale time steps. An observed reduction in the computation work in comparison to the full model was observed, for instance, the computational cost of the EF POD-assisted method was about 6% of that of the full model. The method can capture the main variabilities by a low dimensional system based on the EF POD mode. The root mean square error (RMSE) and correlation were used to evaluate the performance of the method. The RMSE for the upper ocean layer thickness was about 0.3% of the average thickness and the correlation between the upper layer thickness with that from the EF POD model was around 0.99. Compared with the POD method, the method provided more accurate results and it did not require the availability of any explicit equations or the right-hand-side (RHS) of the evolution equation.

Keywords: multi scale problem, equation free, pde

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JMS024 **Poster presentation** **1433**

The analysis of Eastward Subtropical countercurrent in the context of the data assimilation

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In the late sixties of the 20th century, the existence of a peculiar eastward narrow flow in the western north Pacific (20N and 25N) in spring was theoretically predicted. It was named the subtropical countercurrent(STCC). Historical hydrographic data, including those from cooperative study of the kuroshio and adjacent regions (1965-66), revealed that STCC was nearly along the tropic of cancer and existed in the geostrophic-current field throughout the year. Although some numerical experiments and analytical studies have been carried to investigate the formation mechanism of STCC, article constraints are specified in order for STCC to occur. Moreover, due to the coarse resolution of most models and the sparsity of observations, there are few studies for the spatial distribution of STCC in annual scale, and in special year ENSO years. In this paper, a regional, high-resolution, hybrid-coordinate ocean model (HYCOM) is used. To analyze more accurately the temporal variation and spatial distribution of STCC, ENKF data assimilation is also applied to the regional HYCOM. The seasonal and annual variability in the distribution, origin and flow status of STCC will be analyzed. In some special years, e.g. ENSO, some discussion about the evolvement of STCC will be given. The relationship between the a branch of the Kuroshio Countercurrent and STCC is also described. The reason for the coexistence of STCC and nearby eddies will be investigated. The paper will provide an important reference for the formation mechanism of STCC. data assimilation, eastward subtropical countercurrent, eddy,

Keywords: data assimilation, subtropical countercurrent, eddy

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JMS024 **Poster presentation** **1434**

Model bias estimation in carbon data assimilation

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A. Scott Denning, Marek Uliasz, Ravindra S. Lokupitiya, Milija Zupanski

Ensemble-based data assimilation methods are widely used in many disciplines of geosciences. The most common applications of these methods are for estimating optimal initial conditions for numerical forecast models. In this presentation, we employ an ensemble-based data assimilation approach in a less common application - to estimate multiplicative, spatially dependent biases of photosynthesis and respiration CO2 fluxes and their associated uncertainties. Experimental results using a global Parameterized Chemistry Transport Model (PCTM) and a regional Lagrangian Particle Dispersion Model (LPDM) will be presented and discussed. One of the main challenges in both applications is that the available CO2 observations are not sufficient to fully constrain the bias estimation problem, thus the problem is heavily dependent on the error covariance of the model bias. We will examine the error covariance of the bias and the ability of the ensemble-based methods to learn about this covariance from the observations.

Keywords: bias, ensemble, uncertainty

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JMS024 **Poster presentation** **1435**

Mapping of soil moisture with the assimilation of remotely sensed LST: an application to Central Italy

Prof. Giorgio Boni
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Francesca Caparrini, Fabio Castelli, Fabio Delogu, Dara Entekhabi, Francesca Sini

We present here a model for soil wetness indexes and energy fluxes estimation based on the assimilation into the heat diffusion equation applied to the soil of remotely sensed Land Surface Temperatures (LST). The model has been developed aiming to operational applicability of the scheme to different meteorological conditions and land cover types. Two key factors have been addressed: a) the dual effect of soil and vegetation emission on the radiometric temperature observed from satellite and b) the fact that precipitation events occurring during the assimilation period modify the surface thermal dynamics. Such issues can be addressed with specific formulations of the scheme, writing the equations of the physical constraints with regard to parameters that take into account the abovementioned effects. In this work the two formulations of the scheme are presented: i) two sources scheme able to separate fluxes produced by bare soil and vegetation; ii) antecedent precipitation index scheme, able to take in to account the effects of rainfall temporal dynamics on soil wetness. The formulation of the assimilation schemes presented allows to benefit from different types of satellite-based LST products,with different accuracies and temporal/spatial resolutions. The two models are applied to the territory of Tuscany region for a six-months period in 2005. Several moderate precipitation events occurred during the study period, and the area presents a wide variety of land cover types. The results obtained with the two schemes are discussed with reference especially to the capability of the model to detect and adapt to land cover and vegetation changes in space and time. The relative performance for different land cover types and meteorological conditions is analyzed.

Keywords: land surface temperature, energy fluxes, evaporative fraction

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JMS024 **Poster presentation** **1436**

Data Assimilation Experiments with New Covariance Models at Environment Canada

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An atmospheric data assimilation study, which tests two new covariance schemes for the dynamics variables, is presented. The 3D-Var global assimilation system used is similar to the current operational system of the Canadian Meteorological Centre but has a higher lid. The forecast model is the Global Environmental Multiscale (GEM) model, which includes full tropospheric and stratospheric chemistry. A covariance model is introduced at the assimilation step based on the Charney balance and hydrostatic balance, incorporating a linearization about the background state. This coupling between the temperature field and streamfunction allows for flow dependence, and has been shown to improve the quality of analysis increments, particularly in regions of strong flow curvature. A coupling between the streamfunction and the velocity potential is also implemented, by exploiting the quasigeostrophic omega equation and continuity equation, again linearized about the background fields. This approach yields a balanced divergence, and serves as a constraint on high frequency vertical motions, which are believed to cause spurious mixing in some assimilation systems. The separate and combined effects of both approaches are discussed through comparisons with a control experiment.

Keywords: assimilation, balance, constraint

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JMS024 **Poster presentation** **1437**

Can sea surface salinity data constrain rainfall estimates over the ocean?

Dr. Max Yaremchuk
SOEST University of Hawaii IAPSO

Uncertainties in the monthly mean estimates of precipitation are the largest over oceanic regions with the heaviest rainfall. Using the adjoint sensitivity analysis and 4d variational assimilation of sea surface salinity (SSS) data into an ocean model, we show that rainfall estimation errors in the regions of heavy precipitation could be reduced by taking SSS observations into account. Inverse analysis of SSS in the Bay of Bengal also indicates that the monthly mean rainfall of the Global Precipitation Climatology Project (GPCP) is more consistent with SSS and river runoff data than other precipitation climatologies.

Keywords: precipitation, adjoint, salinity

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JMS024 **Poster presentation** **1438**

The South China Sea throughflow retrieved from atmospheric and oceanic climatologies.

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SOEST University of Hawaii IAPSO

Z. Yu, J. Mccreary, R. Furue

The South China Sea Throughflow (SCSTF) is an important contributor to the the only tropical inter-oceanic connection on the Earth's surface - the Indonesian Throughflow. In the absence of in situ measurements, errors in estimating the SCSTF transport using direct numerical simulations are large. This is primarily due to the complicated geometry and uncertainties in parameterization of the sub-grid processes in the numerous straits connecting the SCS with Indonesian Seas. The 4d variational assimilation of the atmospheric and the SCS temperature/salinity climatologies, shows however, that these data are capable to provide observational constraints that are strong enough to determine the overall magnitude of the SCSTF transport and its distribution among the major straits. The data-optimized values of the annual mean transports through the Taiwan, Mindoro, and Karimata straits are 0.5, 1.7 and 0.6 Sv (1 Sv= 106 m3/s) respectively. Our analysis also shows that the major part of the Mindoro outflow is likely to take place below 100 m, inidicating that more than a half of SCSTF may not be directly influenced by the atmosphere on the exit form the South China Sea.

Keywords: assimilation, throughflow

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JMS024 **Poster presentation** **1439**

Preliminary study on surface observational data assimilation

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Gong Jiandong, Wang Jianjie, Li Zechun

With the advances of numerical weather simulation and forecasting, the spatial and temporal resolution of numerical model is much higher and the data assimilation updating cycle is more rapid. Surface Observation Data Assimilation (SODA) becomes more and more important in data assimilation system. But designing a SODA scheme is a tough work. The problem mainly results from two aspects. At first, Surface Observation Data (SOD) is related to land surface process and the atmospheric boundary-layer. Meanwhile, the topography distribution of our country is very complex and there exists different elevation between surface observation station measurement and numerical model surface, which also presents many challenges. Elevation difference between surface observation sites and numerical model surface is one big problem of SODA. In this paper, surface observation data are assimilated into Meso-scale model MM5 using MM5_3DVAR system, and a case study of a heavy rainfall events occurred on 11-12 May 2004 is simulated. At the same time, two surface data assimilation approaches (Ruggieros approach and Guo Yongruns approach) are compared and studied, and the strongpoint and shortcoming of these two assimilation approaches are discussed. The preliminary study shows that using these assimilation approaches to assimilate surface observed data can impact the analysis field from bottom to top of the numerical model, and bring more contribution to the mid-lower layers analysis field while less to the higher layers. Ruggieros approach considers the different elevation between model surface and surface observational sites, but discards too much surface observational data. When the resolution of numerical model is low, the problem of discarding data doesnt impact the analysis field much, but when the resolution of numerical model is higher, the problem becomes sharper, and both the analysis field and 24 hour simulation are impacted negatively. The actual difference in elevation between the observation sites and the model surface (DEOM) is not considered in Guo Yongruns approach. Whether the resolution of numerical model is higher or lower, most of the surface observed data can be used with this approach. But the impact caused by DEOM to the analysis field can not be neglected. Much more work need to be done to improve this approach. When DEOM is put into consideration, better results can be obtained. Because of the complexity consists in the topography distribution of China , these two SODA schemes can not be applied in our country directly. Much work needs to be done to improve these tw SODA schemes or to design a new reasonable and effective SODA scheme.

Keywords: surface observational data, assimilation

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JMS024 **Poster presentation** **1440**

Hybrid method for data assimilation in oceanography

Dr. Monika Krysta

Eric Blayo, Emmanuel Cosme, Cline Robert, Jacques Verron

Two different approaches to data assimilation in oceanography, namely variational and sequential, are commonly used. In a certain sense these approaches proved to be mathematically equivalent, provided that the system and the observation operators are linear. However, the physical processes governing ocean circulation are nonlinear and inevitably lead to approximations in case of practical implementations. These approximations result in inherent suboptimalities and possibly in significant differences between the two methods. Although the variational approach is very powerful, one of its well-known limitations lies in a lack of evolution of the background error covariance matrix from one assimilation window to another. The principal objective of this work is to prove that a consistent coupling of the variational and sequential methods may allow to remedy this disadvantage. Specifically, it is proposed to explore a link between the incremental 4D-Var (Courtier et al., 1994) and the Singular Evolutive Extended Kalman Smoother (SEEKS) derived from the SEEK filter (Pham et al., 1998). The equivalence of the incremental 4D-Var and the extended Kalman smoother (EKS) will be presented first as triggering a construction of a hybrid method (Veers et al., 2000). In the hybrid approach, the error covariance matrix is transported within the EKS framework, in parallel to the evolution of the state vector yielded by the 4D-Var. It can be shown that the analyses produced by the two methods coincide, and consequently that the error covariance matrix computed by the EKS refers to both of them. Hence, the EKS provides the missing update of the forecast error covariance matrix which can be injected into the cost function whenever required. Such an equivalence can be explored in theory but it may be impossible to put it into practice due to a large size of the state vector and the associated matrices. Therefore, secondly, in the view of actual applications the equivalence can be shown to hold also for a reduced control space approach. Here, the evolution of the error covariance matrix is restricted to a low-dimensional space. Consequently, the EKS is superseded by the SEEKS which was built so as to be capable of transporting the arising low-rank matrices in a consistent manner. Moreover, the size of the control vector and background error covariance matrix of the equivalent 4D-Var incremental approach can be reduced accordingly. Further practical considerations such as the advantages of the hybrid approach with respect to both the 4D-Var and Kalman filtering shall also be addressed in the presentation. An application to a shallow water model will be discussed. References: 1. Courtier, P., Thpaut, J.-N., and Hollingsworth, A. 1994. A strategy for operational implementation of 4D-Var, using an incremental approach.Q.J.R. Meteorol. Soc. 120: 1367-1387 2. Pham, D.-T., Verron, J., and Roubaud, M.-C. 1998. A singular evolutive extended Kalman filter for data assimilation in oceanography. J. Mar. Syst. 16: 323-340 3. Veers, F., Pham, D.-T., and Verron, J. 2000. 4D-Var/SEEK: a consistent hybrid variational-smoothing data assimilation method. Scientific Report RR-3902, 21 pp., INRIA Rhne Alpes, Montbonnot, France

Keywords: hybrid method, seek smoother, reduced 4d var

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JMS024 **Poster presentation** **1441**

The AFES-LETKF Experimental Ensemble Reanalysis: ALERA

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The local ensemble transform Kalman filter (LETKF) is applied to the AFES (AGCM for the Earth Simulator) to perform an experimental reanalysis. The reanalysis is called ALERA, standing for AFES-LETKF Experimental ensemble ReAnalysis. Using the system developed by Miyoshi and Yamane (2007), real observations except satellite radiances are assimilated for more than 19 months since 1 May 2005. The AFES-LETKF data assimilation cycle has been stable for over a year. The analysis fields are compared with the NCEP/NCAR reanalysis, a de facto standard reanalysis; the verification indicates that the ALERA data actually reproduce the nature atmosphere fairly well. Moreover, ALERA ensemble spreads capture the analysis uncertainties well, especially large uncertainties in the SH and upper levels where satellite radiances play an important role.

Keywords: data assimilation, ensemble kalman filter, numerical weather prediction

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JMS024 **Poster presentation** **1442**

Hybrid SEIK-3DVar algorithm

Dr. Tijana Janjić

S. Skachko, S. Danilov, J. Schrter

The singular evolutive interpolated Kalmanfilter (SEIK) as a variant of the ensemble Kalman filter (Pham, 2001) has been implemented and tested for application in oceanography assimilating altimetric data within twin experiments framework. Previous studies suggest that this filter is reasonably well-behaved in the presence of instability (Hoteit et al. 2002). However, problems still remain with its performance. For example, in the assimilation algorithm, the analysis error covariance matrix is approximated by a covariance matrix whose rank corresponds to the number of ensemble members used for representing the forecast error covariance. In order to have computationally efficient algorithm the rank of this covariance matrix is often small, leading to problems with the convergence of the filter. For this reason, previous implementations of the algorithm often introduced the forgetting factor in order to stabilize the filter. As an alternative we propose the hybrid of the SEIK and a 3DVar algorithm. The performance of this hybrid algorithm has been tested and compared to the SEIK algorithm using twin experiment set up and a simplified channel configuration of the Finite Element Ocean Model (FEOM) developed at the Alfred Wegener Institute (AWI). In the experiments, we deal with flows generated by baroclinic instability. In this setting, we compare results of the assimilation when only observations of the sea surface height (SSH) data are present, and in the case of observations of the sea surface velocities only. In particular, we consider distribution of the RMS errors with height in all model fields.

Keywords: hybrid, seik

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JMS024 **Poster presentation** **1443**

Estimation of eddies in the Antarctic Circumpolar Current circulation via sequential data assimilation

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Jens Schrter, Sergey Danilov, Tijana Janjić, Dmitry Sidorenko

The study aims at the determination of the absolute ocean circulation flow field and of associated mass and heat transports of the Antarctic Circumpolar Current (ACC) and the Weddell Sea, one of the most dynamic ocean areas and one of the most critical regions for global climate, due to the impact of circumpolar bottom water production on global deep sea circulation. However, the determination of the transport of the ACC is still a problem in ocean modelling. The using of dynamic sea surface topography provided by satellite altimetry is expected to be a promising solution to correctly estimate absolute current fields and oceanic transports. On the other hand, sea surface topography field does not uniquely determine the state of the ocean, because its statistical correction obtained via assimilation process is restricted to the ocean surface and does not interfere with physical process of water mass formation. Hence, knowledge of ocean dynamics is needed to infer correctly subsurface information from the altimetry data. The first part of our work is carried out to account for this difficulty in terms of twin assimilation experiments within a finite element ocean model (FEOM), in its simplified channel configuration roughly simulating the ACC current. The second part of the work uses a global configuration of our model where a high resolution regional model of the Atlantic sector of the ACC is embedded into a coarser global model to avoid systematic distortions. It is supposed to use developed assimilation method to assimilate real multi-mission satellite altimetry data.

Keywords: data, assimilation, altimetry

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JMS024 **Poster presentation** **1444**

Sensitivity test to Ensemble Kalman Filter implemented to Regional Ocean Modeling System

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Sang Jin Lyu, Yang-Ki Cho, Byoung-Ju Choi, Kyung-Il Chang, Yong-Hoon Youn

The Kalman Filter is a powerful framework of a sequential data assimilation, in which the background error covariance is evolved by a forecast from the previous analysis. The expensive computation, however, has kept from the practical implementation. Though the ensemble Kalman Filter (EnKF) was introduced by Evensen (1994) and has been applied successfully in meteorological applications, there are few oceanographic applications. The EnKF was employed for the Regional Ocean Modeling System (ROMS) in this study. The technical approaches are based on the algorithm suggested by Evensen (1994) and modified by Houtekamer and Mitchell (1998). In spite of merits of the EnKF, there can be some issues due to the finite ensemble size, which can make the estimated forecast error covariance noisy. Furthermore, the EnKF can underestimate the rank of the error covariance since the forecast error covariance is estimated from the finite ensemble members, which can cause the Kalman Filter to diverge. To deal with these issues in the EnKF, covariance localization has been suggested by Gaspari and Cohn (1999) and covariance inflation by Wang and Bishop (2003). To discuss the issues of the EnKF to implement to the ROMS, sensitivity test to the covariance localization and inflation has been conducted using twin experiments in the simple case of the ROMS. Analysis error and its uncertainty with or without the covariance localization and inflation will be discussed. In addition, the multivariate forecast error covariance has been applied and will be discussed.

Keywords: assimilation, enkf, roms

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JMS024 **Poster presentation** **1445**

Combining synthetic Argo hydrology and sea surface height with an eddy-permitting primitive equation model using a 4D-variational method - Preliminary results

Dr. Bruno Ferron
IFREMER CNRS

Describing and understanding the oceanic variability and the associated physical processes at decadal to intra-decadal timescales is a challenging topic for which current observational networks are of key importance. The Argo float network provides vertical in-situ profiles of temperature and salinity with a period of 10 days that mainly describes the large horizontal oceanic scales. With roughly the same period, the sea surface height measured by satellite altimeters is another important source of oceanic state information especially at meso-scale. It is thus tempting to combine those sets of observations with a dynamical model able to represent most of those observed features in order to get the best description of the real ocean as possible. The model then needs to be at least eddy-permitting which poses some problems due to the increased non-linearities compared to assimilation at coarse resolutions. Consequently, new strategies have to be defined and tested. In this study, synthetic vertical profiles of temperature and salinity mimicking the Argo network and synthetic maps of absolute sea surface height are combined with a primitive equation model to estimate the state of the ocean using twin experiments and a 4D-variational method. The exercise is applied to a configuration of the North Atlantic with a 1/3 horizontal resolution. The aim of those experiments is to test the limitations of the method in a idealized context before applying this method to real observations in order to study the oceanic variability. In this exercise, both the model and the synthetic data are perfect. In order to produce analyses as close as possible to observations and avoid model error accumulation due to improper internal model dynamics, the choice is made to only control the initial state, what naturally limits the extent of the assimilation window. Several experiments are shown in which either Argo-like or synthetic sea surface height observations are used with different assimilation window lengths and different strategies for cycling the assimilation windows. The last set of experiments shows results from the joint assimilation of both sets of observations.

Keywords: eddy permitting, 4d variationnal assimilation, argo altimetry

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JMS024 **Poster presentation** **1446**

An evaluation of satellite-derived total column measurements using a data assimilation system: application to the Ozone Monitoring Instrument

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Roger Brugge, Alan O'Neill, Marcel Dobber, Pieternel Levelt, Richard Mcpeters

On 15 July 2004 the Ozone Monitoring Instrument (OMI) aboard the EOS Aura missionwas launched. One of OMI's priorities is to continue the record of high spatial resolution total ozone column measurements provided by the various Total Ozone Mapping Spectrometer (TOMS) instruments since 1978.To this end, it is essential to estimate the errors affecting OMI total ozone column measurementsand to see whether the actual accuracy is consistent with estimated values before launch.In this presentation the OMI ozone column measurements obtained with the TOMS-V8 total ozone algorithm are evaluated against ozone analyses resulting from assimilation of standard meteorological observations as well as independent ozone retrievals into a numerical weather prediction model.An accurate discussion of relevant error sources, vertical resolution and contributions from priorinformation is provided.

Keywords: omi, validation

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JMS024 **Poster presentation** **1447**

Evaluation of the WVSS-II moisture sensor using co-located in-situ and remotely sensed observations

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Sarah Bedka, Wayne Feltz, Erik Olson

Information on the accuracy and representativeness of new observing systems is critical for their optimal use in NWP data assimilation systems. In an attempt to provide this information for the WVSS-II moisture sensing instruments being currently deployed on commercial aircraft in the US, a series of objective study have conducted to assess the accuracy of the humidity data and to help determine how to use these data as a supplement to or surrogate for traditional upper-air reports. The assessments were made during June 2005 and November 2006 using facilities provided by the UW mobile observing system located at Louisville, KY where about 80% of the WVSS-II equipped planes land and/or take-off daily. A total of between 25 and 30 UPS B757 aircraft provided en-route and profile reports data for the assessments. Intercomparison data sets included 1) an infrared AERI system (providing very high time frequency boundary layer T/q profiles), 2) surface GPS (providing total atmospheric moisture content), 3) standard surface observations (Temp, Wind, Moisture and Ceiling), 4) a portable GPS rawinsonde system, and 5) geostationary and polar satellite data. Approximately 2 weeks of collocated radiosonde and aircraft data were be collected during each test period with radiosonde launched 3 times nightly, immediately before, between and after periods of multiple aircraft arrivals/departures. On average, more than 5 co-locations (within 1 hour and 50 km) were obtained daily, including Temperature, Wind Direction / Speed, and Humidity reports. The WVSS-II assessment focused primarily on water vapor measurement accuracy throughout the troposphere. Comparisons showed generally excellent agreement, especially in the lower troposphere, where the RMS fits approached 0.5 g/kg for mixing ratio and 5% for relative humidity. In addition to testing the engineering aspects of the WVSS-II systems, statistical evaluations were made of the performance of a variety of factors important for the optimal objective use of the aircraft data in combination with other data sources by assessing: 1) Similarity of reports from the different observing systems and different aircraft, 2) Biases between ascent and descent reports from individual aircraft, 3) Variability between different aircraft (to assess instrument calibration and effects of aging), and 4) Capabilities of the systems to capture sharp moisture gradients accurately, including after an aircraft emerges from clouds. A supplementary study is also underway to help determine the optimal temporal and spatial distribution of moisture reports through time-series analysis of high-time-frequency co-located Wind Profiler and AERI moisture profiles. Additional details of the assessment results will be presented, along with a discussion of future program plans.

Keywords: wvss ii, aircraft, moisture

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JMS024 **Poster presentation** **1448**

Ozonesonde performance and comparisons

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E. Thomas Northam, B. Morrison, Franciso Raimundo Da Silva, George Brothers

Electrochemical Concentration Cell (ECC) ozonesondes flown from Wallops Flight Facility, Virginia, undergo careful preparation to correct instrument anomalies that might compromise valid ozone measurements. Pre-flight calibration includes pump efficiency, flow rate, sampling-air temperature, background current, and transmission quality and reliability when coupled to its radiosonde. UV photometer measurements of the same ozone concentration used to calibrate the ECC provides an adjustment factor that may be included in the ozone equation. Ozonesondes also are flown in Brazil and Ascension Island where NASA has cooperative agreements for weekly ECC observations. We present results from instrumental comparisons that include simultaneous ECC observations. Conclusions from the tests JOSIE2000 and BESOS as they apply to Wallops procedures will be discussed. Validation of remotely measured ozone and long-term measurements and comparisons between the balloon-borne ECC and AIRS and AURA satellite measured ozone are also discussed.

Keywords: ozone, instruments, atmosphere

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JMS024 **Poster presentation** **1449**

Influence of coexistent gases on heterogeneous uptake and oxidation of sulfur dioxide on chinese losses particles

Prof. Kazuhiko Sakamoto
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Yo Tonegawa, Yoichi Horita, Atsuyuki Sorimach, Hidekazu Ishihara, Masataka Nishikawa

In order to obtain information about influence of moisture and acidic gases (HF, HNO3 and oxalic acid) on heterogeneous uptake and oxidation of SO2 on Chinese loess particles, laboratory experiments were performed in the use of a cylindrical flow reactor. The uptake of SO2 was constricted in the presence of HF, HNO3, and oxalic acid at <10% relative humidity (RH) due possibly to the blockage of reactive sites of the particle surface by a high uptake of acidic gases. At 80% RH, the uptake of SO2 increased significantly in comparison with that at <10% RH in spite of the presence of NO2 and HNO3, suggesting that moisture on the particle surfaces was significant for SO2 uptake. The sulfur (IV) oxidation at <10% RH occurred by about 30% relative to SO2 adsorbed on the particles, and in addition to NO2 and HNO3 a synergic effect was observed. At 80% RH, S(IV) oxidation increased by a factor of about 2 in comparison with that at <10% RH, suggesting that the transition metal-catalyzed reactions occurred on aqueous phase on the particles. Accordingly, moisture and/or gaseous components coexisting in the air were considered to play an important role in uptake and oxidation of SO2 on the loess particles.

Keywords: heterogeneous uptake, sulfur oxidation, acidic gas

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JMS025 **1450 - 1474**

Symposium
3D Radiative Transfer in Complex Geophysical Media Including Clouds, Vegetation, Ice and Snow

Convener : Dr. Robert Cahalan

Papers are invited on modeling and observations involving three-dimensional (3D) radiative transfer (RT) applications to the Earth's atmosphere and surface (vegetation, land and sea ice). We are interested in aspects of solar ultraviolet (UV) radiation (e.g. actinic flux; irradiance on horizontal and tilted receivers including biological ones); visible and near-infrared radiation with applications to solar radiative transfer and remote sensing; and 3D effects due to variations in thermal absorption and emissivity. We expect methods for identifying errors and limits of various RT methods, and highlighting 3D effects characteristic of UV, Vis-NIR, and thermal RT. We strongly encourage papers on new approaches explicitly considering 3D radiative effects

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JMS025 **Oral Presentation** **1450**

Simulation of stochastic fields of broken clouds using satellite and ground-based observations

Prof. Sergey Prigarin
Stochastic Simulation Institute of Comp. Math. & Mathem. Geophysics IAMAS

Marshak, Alexander

An important problem of the atmosphere optics is to study the influence of stochastic structure of broken clouds on characteristics of radiation fields. Numerical stochastic models and 3D radiative transfer codes can be used as effective tools to explore the problem. In the paper we present a new 3D stochastic model of broken clouds, that can be adjusted according to satellite or ground-based observations. The model input parameters are an autocorrelation function of the cloud indicator field and joint distributions of cloud optical and geometrical characteristics. A numerical algorithm is constructed on the basis of spectral models of homogeneous random fields and nonlinear transformations of Gaussian functions. The proposed approach to simulate broken clouds is characterized by relative simplicity, universality, and it enables to reproduce basic geometrical and optical properties of clouds evaluated from experimental data. We present numerical models of broken clouds adapted to MODIS observations and ground measurements collected at the ARM TWP site. The research was partially supported by INTAS (05-1000008-8024), RFBR (06-05-64484a), and Russian Presidential Program Leading scientific schools (НШ-4774.2006.1). %%% [1] S.M. Prigarin, A.L. Marshak, 2005: Simulation model of broken clouds adapted to observations, Atmospheric and Oceanic Optics, 18, 256-263.

Keywords: broken clouds, stochastic simulation, atmosphere optics

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JMS025 **Oral Presentation** **1451**

Cloud vertical and horizontal structure from ICESat/GLAS and MODIS

Dr. Alexander Marshak
NASA - Goddard Space Flight Center NASA IAMAS

Alexander Marshak, Christine Chiu, Anthony Davis, Warren Wiscombe

To accurately model radiative fluxes at the surface and within the atmosphere, we need to know both vertical and horizontal structures of cloudiness. While MODIS provides accurate information on cloud horizontal structure, it has limited ability to estimate cloud vertical structure. ICESat/GLAS on the other hand, provides the vertical distribution and internal structure of clouds as deep as the laser beam can penetrate and return a signal. Having different orbits, MODIS and GLAS provide few collocated measurements; hence a statistical approach is needed to learn about 3D cloud structures from the two instruments. In the presentation, we show the results of the statistical analysis of vertical and horizontal structure of cloudiness using GLAS and MODIS cloud top(s) data acquired in October-November 2003. We revisit the (H1,C1) plot, previously used for analyzing cloud liquid water data, and illustrate cloud structure for single and multiple-layer clouds.

Keywords: cloud, icesat, modis

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JMS025 **Oral Presentation** **1452**

How can 3D radiative transfer help correctly interpret satellite data on aerosol-cloud interactions?

Dr. Robert Cahalan
Climate and Radiation NASAGoddard Space Flight Center IAMAS

Alexander Marshak, Guoyong Wen, Tamas Varnai

Clouds are the most strikingly complex 3D objects in Earth's atmosphere. One consequence is the radiative properties of each cloudy pixel are effected by its neighbors. Current operational retrievals of cloud and aerosol properties treat each pixel independently of its neighbors, assuming no radiative interactions between them. We quantify the influence of 3D radiative effects on MODIS-derived cloud optical thickness, particle size, and aerosol optical thickness. We demonstrate and discuss how to combine multi-spectral MODIS information on spatial variability with MISR multi-angle information and ASTER sub-pixel information, to derive aerosol-cloud relations that correctly account for 3D radiative effects.

Keywords: aerosol, clouds, 3d

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JMS025 **Oral Presentation** **1453**

Diurnal variation of three-dimensional radiative effects in cloudy atmospheres

Dr. Hironobu Iwabuchi

The one-dimensional radiative transfer approximation neglects the net horizontal radiative transport. Many studies showed that this approximation causes errors in solar radiative fluxes and heating rates, depending on horizontal inhomogeneity of clouds. The error can be regarded as the three-dimensional radiative effect, which is notable especially at local scales. The domain-averaged error is also not negligible when the solar hight is low and the inhomogeneity is large. In this study, diurnal variation of three-dimensional radiative effects in cloudy atmospheres is studied for several types of cloud systems. It is possible that the three-dimensional radiative effects vary in the diurnal cycle, in which the solar height and cloud inhomogeneity change with different timings. Because the diurnal cycles of atmosphere-ocean-land system are different by cloud types, we carried out simulations for two cases with different cloud types; tropical convective clouds and marine stratocumulus clouds. Using the cloud and atmospheric fields simulated by a cloud-resolving dynamical models, radiative fluxes and heating rates in the solar and infrared spectra are simulated using a broadband radiative transfer model. The model basically uses Monte Carlo multiple scattering algorithms, but solar direct component of the radiative flux and heating rate of the first-order scattering is calculated in a semi-analytical way in the model. Relationship between spatial distributions of the cloud mass and radiative quantities (direct/diffuse fluxes and heating rates) are examined, and we discuss possibilities of economical temporal interpolation scheme for radiation calculations in dynamical simulations.

Keywords: cloud, radiation, simulation

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JMS025 **Oral Presentation** **1454**

Monte Carlo simulation of 3D radiation transfer in water-drop and crystal clouds with allowance for polarization and optical anisotropy

Prof. Sergey Prigarin
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Borovoi, Anatoli, Bruscaglioni, Piero, Oppel, Ulrich, Czerwinski, Guenter, Cohen, Ariel

Keywords: polarized radiation transfer, monte carlo simulation, water and ice clouds

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JMS025 **Oral Presentation** **1455**

A study of the probability of clear line of sight (PCLoS) through cumulus clouds in the tropical western Pacific

Prof. Robert Ellingson
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Patrick C. Taylor

The plane-parallel hypothesis (PPH) used to approximate clouds in global climate models neglects the 3-D effects of clouds. Such effects can contribute as much as 20 Wm-2 to the downward longwave flux at the surface. Several investigators have proposed accounting for longwave 3-D cloud effects by using information on the Probability of Clear Line of Sight (PCLoS) to modify the PPH approximation. This study investigates the PCLoS at the Atmosphere Radiation Measurement (ARM) Programs Tropical Western Pacific (TWP) site and its dependence on cloud properties. PCLoS is determined for single-layer cumulus events over 2-hour intervals using Whole Sky Imager (WSI) data at the Nauru and Manus sites simultaneous to numerous observations of the location of cloud boundaries and the downward longwave flux. The WSI PCLoS is compared to calculations from a set of PCLoS models using measured cloud field statistics as input (e.g., cloud fraction and aspect ratio). A PCLoS climatology is also prepared for the observation periods at both sites, and the results are used to investigate the spatial variability of the PCLoS and effects on the downward longwave flux at the surface. Comparisons to similar data obtained at the ARM Southern Great Plains site will also be made.

Keywords: pclos

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JMS025 **Oral Presentation** **1456**

3D radiative transfer effects as observed by ground-based passive microwave radiometers

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Clemens Simmer, Francesco Lucci

Because of its lower computational cost the backward Monte Carlo techniques based on importance sampling represents the most efficient way to face passive microwave radiative transfer problems related to optically thick 3-D structured clouds including non-spherical, preferentially oriented hydrometeors (e.g. raining clouds). Consistent negative polarization differences (i.e. differences between the vertical and the horizontal brightness temperature) are observed when looking at precipitating systems by ground-based radiometers at slant angles. These signatures can be partially explained by one-dimensional radiative transfer computations that include oriented non-spherical raindrops. However some cases are characterized by polarization values that exceed differences expected from one-dimensional radiative transfer.After being intercompared with other codes, a 3D backward, fully polarized Monte Carlo model has been used to evaluate the impact of the horizontal finiteness of rain shafts with different rain rates at 10, 19, and 30 GHz.Case studies involving rain shafts populated by perfectly oriented oblate raindrops are analysed in detail, including a discussion of the behaviour of all four Stokes components.The results show that because of the reduced slant optical thickness in finite clouds, the polarization signal can strongly differ from its one-dimensional counterpart. At higher frequencies, and when the radiometer is positioned underneath the cloud, significantly higher negative polarisation values are found which are also consistent with some observations. When the observation point is located outside of the precipitating cloud, typical polarization patterns (with troughs and peaks) as a function of the observation angle are predicted.An approximate 1-D slant path radiative transfer model is considered as well and its results are compared with the full 3-D simulations to investigate whether or not 3D effects can be explained by geometry alone. ADMIRARI (Advanced Microwave Radiometer for Rain Identification), a multi-wavelength, polarized and fully steerable radiometer, now operating in the COPS (Convective Orographic Precipitation Studies) field campaign in South Germany, will provide a unique validation source for verifying 3D effects in ground-based microwave radiometry.

Keywords: microwave, rain, polarimetry

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JMS025 **Oral Presentation** **1457**

Retrieval of Inhomogeneous Cloud Parameter From Multispectral and Multiscale Radiance Data using Neural Networks in the Framework of the I3RC-Case 6

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Szczap Frdric

Operational retrieval of cloud parameters remains based on the use of infinite homogeneous plane parallel layers whereas numerous studies questionned this approximation and showed that the 3D variability of cloud must be accounted for. Improvements of radiometric observationnal capabilities allow the development of new approches in the retrieval of cloud properties. In this context, we developed a method to retrieve heterogeneous and fractional cloud parameters using neural network techniques. The inverse model is defined, at the scale of the retrieval, by six cloud parameters: the mean optical thickness and effective radius, their standard deviations, the fractional cloud cover and the cloud top temperature. The retrieval scheme makes use of the information contained in the multispectral and multiscale data given by radiometer such as MODIS.This retrieval method is tested in the framework of the Case 6 defined by I3RC (Intercomparison of 3D Radiation Codes). This is a broken cumulus cloud scene above Brazil. The retrieved parameters are compared with those obtained with the MODIS operational algorithm that use the homogeneous cloud assumption.Additionnally, using the moderate resolution (1km) of retrieved cloud parameters, a high resolution (50m) cloud field is reconstructed using a Fourier method. Radiances are then simulated in order to make comparison with those observed by the Multi-angle Imaging SpectroRadiometer, MISR.

Keywords: remote sensing, 3d cloud, neural network

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JMS025 **Oral Presentation** **1458**

About sensitivity of mean solar radiative fluxes to 3D effects in two-layer broken clouds

Dr. Tatiana Zhuravleva

It is well known that the horizontal inhomogeneity can lead to significant transformation of the radiative regime of single-layered clouds. So, a relevant question is how strongly does the horizontal inhomogeneity influence the radiative properties of multilayer clouds? The present work explores one aspect of the problem, namely the variations of the mean fluxes of visible solar radiation in two-layer broken clouds due to the 3D cloud effects. A cloudy-aerosol atmospheric model is considered, in which two layers are occupied by broken clouds. We assume that the cloud layers are situated within the limits of different layers (low, middle, or high), and neglect the vertical correlations between the components of complicated cloudy systems. In each layer, the clouds are simulated independently, using mathematical cloud model constructed on the basis of the Poisson point fluxes on the straight lines. To calculate the mean fluxes of solar radiation at different atmospheric levels, we use the method of closed equations, based upon Monte Carlo solution of the system of equations for the mean intensity. It is shown that, in comparison with the classical technique based on the solution of radiative transfer equation with deterministic optical characteristics and hypotheses of maximum/random overlap, this approach has an advantage of providing more exact description of the stochastic structure of real clouds and the radiative interaction between the broken cloud layers. In this study we consider in detail one of the typical two-layer systems of the broken clouds, whose upper layer is occupied by optically thin stratiform ice clouds (τhigh ~1, aspect ratio γhigh=H/D<<1, H is the geometrical thickness, and D is the mean horizontal cloud size). The optically dense low-level liquid water clouds (τlow ~10-40) are either stratiform (γlow<<1) or are the convective clouds (0.5≤γlow≤2), in which the transformation of solar radiation is determined to a considerable degree by the effects of the stochastic geometry of the cloud field. The paper discusses how strongly the mean albedo and transmission of two-layer clouds depend on γlow for different solar zenith angles (SZAs) and cloud amounts N within each layer. It is shown that the influence of 3D effects of low-level clouds on the mean radiation regime decreases with growth of Nhigh: in particular, for large SZA>60 and with variations of cloud amount in the upper layer from Nhigh=0 to Nhigh=1, the relative difference in system albedo, caused by the 3D effects, decreases from 40 to 20% for medium Nlow. We also examine how the radiation regime of two-layer clouds changes when the ice clouds are modeled as extended bands. This work is partially supported by Russian Fund for Basic Research (under grant 06-05-64484).

Keywords: broken clouds, solar radiation

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JMS025 **Oral Presentation** **1459**

Simulation of solar radiation during a total solar eclipse: a challenge for radiative transfer

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A solar eclipse is a rare but spectacular natural phenomenon. Furthermore it is a challenge for radiative transfer modeling and an excellent opportunity for the validation of a three-dimensional radiative transfer code. Whereas a simple one-dimensional radiative transfer model with reduced solar irradiance at the top of the atmosphere can be used to calculate the brightness during partial eclipses, a much more sophisticated model is required to calculate the brightness (i.e. the diffuse radiation) during a total eclipse. The reason it that radiation reaching a detector in the shadow gets there exclusively byhorizontal (three-dimensional) transport of photons in a spherical shell atmosphere. In this study the first accurate simulations are presented examplified by the solar eclipse at 29 March 2006. Using a backward Monte Carlo model we calculated the diffuse radiation in the umbra and simulated the changing colors of the sky. Radiance and irradiance are decreased by 3 to 4 orders of magnitude, depending on wavelength. We found that aerosol has a comparatively small impact on the radiation in the umbra. We also estimated the contribution of the solar corona to the radiation under the umbra and found that it is negligible compared to the diffuse solar radiation in most parts of the spectrum. We compared the model results to some measurements taken during the eclipse and found quantitative agreement. Such measurements are challenging due to the low intensity. Careful planning supported by the new model could improve measurements during future solar eclipses significantly.

Keywords: 3d radiative transfer, solar eclipse, solar radiation

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JMS025 **Oral Presentation** **1460**

Multiangle radiances measured by MISR for a deep convective cloud compared to those from a 3D radiation model

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Celine Cornet

We constrain the input to a 3D Monte Carlo model of radiative transfer in a deep convective cloud using stereo measurements of the cloud geometry. The effect of different assumptions about the internal cloud properties, especially the distribution of the extinction coefficient, is explored by matching the modeled and measured radiances emerging from the top and sides of the cloud. In so doing we obtain estimates of the total cloud optical depth that greatly exceed the saturation limit inherent from single angle views.

Keywords: 3d radiative transfer, cloud optical depth, multiangle remote sensing

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JMS025 **Oral Presentation** **1461**

Is there a resolution limit to trace gas retrieval from space?

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New sensors to measure the UV-vis radiance from space have been developed. These sensors have better horizontal spatial resolution, in order to maximize cloud free pixels and thus allow more useful retrievals of vertical amounts of trace gases.However, the column amount of trace gases are not determined directly, but using retrieval algorithms that translate measured radiances into vertical trace gas columns.Since radiation does not necessarily travel from the sun to the earth and back to the satellite instrument, the information carried by the radiation reaching the satellite is normally diffuse in nature, especially in the presence of clouds and aerosols in the UV-vis spectral range. Due to these effects, reducing the pixel sizes beyond a certain limit would not increase the actual resolution.Although this smoothing of trace gas absorption is well known from theory, it is largely ignored in discussions that aim at nadir-looking instruments with high horizontal resolution.In this presentation a first attempt is presented to evaluate the impact of radiative smoothing on satellite remote sensing. Here the adjoint Monto Carlo 3D radiative transfer model McSCIA, that uses the Equivalence Theorem to seperate atmospheric absorption and scattering, is employed. Results indicate that for cases with very small ground pixels (e.g. 4x4 km, 440 nm for tropospheric NO_2), the information about trace gases is coming more from from outside the sub-satellite volume than from inside.A first estimate of effects due to uniform cloud cover and uniform aerosol distributions are also presented.

Keywords: radiative transfer, three dimensional, radiative smoothing

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JMS025 **Oral Presentation** **1462**

Cloud microphysics retrieval in highly three-dimensional situations

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Alexander Marshak, Vanderlei Martins

The CLAIM-3D (cloud aerosol interaction mission in 3-D) passive cloud side viewing sensor concept is planned to become a new means of measuring the vertical profile of cloud microphysical properties, e.g., from airborne perspective or eventually from a satellite platform. Inherent to the complex viewing and illumination geometry and the fact that such a profile has to be derived on high spatial resolution is the need for the consideration of 3D radiative transport. Based on a large number of realistic deep convection cloud scenes from a 3D cloud resolving model (Goddard Cumulus Ensemble model) a data base of related observable radiances is generated, using a 3D Monte Carlo radiative transfer model (MYSTIC). Presented are the technical optimizations and the necessary trade-offs between Monte Carlo model accuracy and computational speed in order to facilitate the generation of a large data base of simulated observations in channels in the visible, NIR and IR spectral range. This data set is then used to explore the limitations of a conventional plane-parallel approach to the cloud side remote sensing of profiles of cloud phase and effective particle size. Furthermore it is demonstrated how the data base can as well serve as the basis for a Bayesian retrieval algorithm of the same properties which is accounting for the uncertainty due to 3D radiative effects and the variability of the cloud particle population.

Keywords: cloud remote sensing, 3d radiative transfer, deep convection

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JMS025 **Oral Presentation** **1463**

Remote sensing of a fully 3D cloud from measurements of zenith radiance

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Alexander Marshak, Yuri Knyazikhin, Warren Wiscombe

We have successfully retrieve optical properties of overhead clouds that range from patchy to overcast, using a ground-based passive two-channel Narrow Field-Of-View Radiometer (2NFOV). The 2NFOV measures zenith radiances at 673 (RED) and 870 nm (NIR) wavelengths. This retrieval method is based on the fact that at RED and NIR channels clouds have nearly identical optical properties, while vegetated surface reflect quite differently. This contrast in spectral surface reflectance leads to substantially different amounts of surface-cloud interactions in these two spectral regions. From the resulting difference in zenith radiance, information on clouds in a fully 3D situation can be extracted. This method retrieves not only cloud optical depth but also radiative cloud fraction. Due to the one-second time resolution of the radiance measurements, we are able, for the first time, to capture changes in cloud optical properties at the natural time scale of cloud evolution.

Keywords: cloud optical property, zenith radiance, surface reflectance

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JMS025 **Oral Presentation** **1464**

Climatology of 3D radiative effects in Collection 5 MODIS data

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Alexander Marshak

This study examines the influence of horizontal cloud variability on satellite retrievals of cloud properties such as optical thickness and droplet size. Current methods estimate these cloud properties using 1D radiative theory, which assumes homogeneity in horizontal directions. This assumption has been shown to cause significant errors in situations where 3D processes such as shadowing are strong-but the influence on satellite-based cloud climatologies remains unknown. The present study examines the climatology of 3D effects by combining a statistical analysis of Collection 5 MODIS cloud products with 3D radiative transfer simulations. In particular, we examine the way 3D effects cause artificial asymmetries and sun-view dependencies in MODIS cloud property fields, and explore whether theoretical simulations constrained by statistics on horizontal cloud variability can explain the detected asymmetries and angle-dependencies. We also examine how to select areas free of 3D effects and how to assess vertical profiles of cloud drop size using observed statistical view angle dependencies.

Keywords: cloud, inhomogeneity, satellite

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JMS025 **Oral Presentation** **1465**

Phase 3 of the Intercomparison of 3D Radiative Codes (I3RC) project

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Alexander Marshak, Robert F. Cahalan

The I3RC project was initiated in the mid 1990-ies with the main goals of comparing various techniques for 3D atmospheric radiative transfer calculations, providing benchmark results for testing new 3D radiative transfer codes, and publishing an open source toolkit for 3D radiative simulations. Throughout the years, I3RC progressed in subsequent phases that involved 3D simulations for increasingly complex situations. This presentation reports on results from the currently ongoing third phase of this project, which contains two groups of experiments. The first group includes simulations of solar reflection in a broken cumulus field over variable terrain, a scene that was reconstructed using observations from multiple instruments on the Terra satellite. The second group includes simulations of the time-dependent 3D spread of lidar pulses in thick clouds. The presentation will highlight the most important insights gained from analyzing the results submitted by I3RC participants. It will also discuss recent developments and future plans regarding the I3RC toolkit and other I3RC resources, such as the I3RC web site at http://i3rc.gsfc.nasa.gov.

Keywords: three dimensional, radiation, intercomparison

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JMS025 **Oral Presentation** **1466**

Potential for airborne offbeam lidar measurements of snow and sea ice thickness

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Robert F. Cahalan

This presentation discusses the capabilities and limitations of a new approach to airborne measurements of snow and sea ice thickness. Such measurements can help better understand snow and sea ice processes, and can also contribute to the validation of satellite measurements. The approach discussed here determines snow and sea ice thickness by using an offbeam lidar to observe the horizontal spread of a narrowly focused light beam. The bright halo observed around an illuminated spot extends farther out in thicker layers, because photons can travel longer without escaping through the bottom. Since earlier studies already provided ground-based demonstrations of such sea ice measurements, this study presents a theoretical analysis of additional uncertainties that arise in airborne observations of snow and sea ice. Snow and sea ice measurements pose different challenges because while sea ice is usually much thicker, snow contains a much higher concentration of scatterers (there are more crystals in snow than bubbles in ice). As a consequence, sea ice halos are larger but snow halos are brighter. The results indicate that airborne sea ice measurements are possible at night and that snow measurements are possible during both night and day. For moderate snow and sea ice thicknesses (around 30-50 cm for snow and 3 m for ice), limitations in instrument performance are expected to cause measurement uncertainties on the order of 10%. These results indicate that instruments using the new approach have the potential to become an important component of future snow and sea ice observing systems.

Keywords: lidar, sea ice, thickness

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JMS025 **Oral Presentation** **1467**

Unresolved Multi-Scale Optical Variability of Clouds: Impact on Photon Path Length Statistics from Oxygen A-Band Spectroscopy

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Cloud-friendly radiative transfer (RT) theory is needed for both accurate energy budget estimation at scales ranging from a single cell in a 3D cloud process model (~m) to GCM grid cells (~105 m) as well as for physically-correct exploitation of remote sensing signals at scales ranging from the smallest satellite pixels (~m) to domains commensurate with the thickness of the cloudy atmosphere (~104 m). A major challenge in RT, atmospheric or other, is to account for the bulk effects of unresolved variability irrespective of the artificial computational or observational scale of reference. This is especially true in the study of dense clouds and cloud fields, possibly over a varying reflective surface, at wavelengths dominated by complex multiple scattering/reflection processes unfolding in 3D space and time. Starting with the generic time-dependent 3D RT equation, general probabilistic arguments and tractable stochastic models lead to robust predictions for the statistical properties of the mean propagation kernel in homogeneous and isotropic but otherwise random yet spatially correlated optical media. It is no longer exponential; rather, it has a power-law decay. This new kernel is used to formulate a mean-field RT theory for domain-average 3D RT that is mathematically similar to classic 1D RT. However, this new 1D RT theory with power-law jump probabilities calls for altered numerical solutions and it has radically different asymptotic properties than its well-known counterpart with exponentially-distributed jumps between scatterings.We will present a spectacularly successful application of this new statistical radiation transport physics to recent state-of-the-art absorption-line spectroscopy in the "A" band of molecular oxygen (760-770 nm) from ground level under a wide variety of cloudy skies. Thanks to excellent out-of-band rejection, these high resolution spectra yield the mean as well as variance of path lengths for solar radiation in cloudy atmospheric columns. In particular, this success of large-scale 3D RT theory makes the outlook towards space-based capability in O2 A-band spectroscopy (with NASA's Orbiting Carbon Observatory) very exciting. Lastly, ramifications for GCM parameterizations of shortwave RT will be discussed.

Keywords: solar radiative transfer, 3d clouds, gcm parameterization

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JMS025 **Oral Presentation** **1468**

The impact of horizontal fluxes on in-situ and space-borne measurements of forest properties.

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Bernard Pinty, Thomas Lavergne, Michel M. Verstraete, Nadine Gobron

Vegetation canopies are inherently 3-D, with various levels of clumping occuring at different scales: the within-crown, the tree and the canopy level. The impact that horizontal radiation fluxes may have with respect to the measureable radiative properties of a given canopy segment (e.g., albedo, absorption, etc.), depends not only on the spatial resolution of the observing sensor but also on the actual location of that footprint area within a larger canopy target. This is because the typical horizontal distances that photons are capable of travelling within a vegetation canopy are affected by 1) the actual structural of the medium, 2) the spectral poperties of the medium (and its lower boundary conditions), and 3) the illumination conditions (affecting the upper boundary condition) of the medium. We will show spatial resolution dependent results describing the impact of horizontal fluxes on both albedo and canopy absorption, as well as, bounded relationships between local absorption measures and horizontal fluxes at very high spatial resolutions. We will also present results indicating s fine spatial resolution limit for pixel-based inversion efforts of remote sensing measurements. These information are of relevance both in the design of future space missions and field validation campains targeting the validation of remote sensed products over land.

Keywords: vegetation canopy, horizontal fluxes, multiple scales

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JMS025 **Oral Presentation** **1469**

Measurements of Cloud Side Radiances and the Retrieval of the Vertical Profile of Cloud Droplet Size and Thermodynamic Phase.

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Alexander Marshak, Tobias Zinner, Lorraine A. Remer, Roberto Fernandez-Borda

Cloud side measurements provide a unique opportunity for the remote sensing of the vertical profile of cloud droplet size, and thermodynamic phase as a function of temperature. These measurements provide a quasi-instantaneous snapshot of the cloud droplet microphysical and thermodynamic states as a function of height and brightness temperature in clouds at several development stages. Although in situ measurements have provided insights in this direction, they always have limitations with the fast time evolution of deep convective clouds, and with the intrinsic risk of flying inside strong storms. Cloud side remote sensing can facilitate the measurement of the microphysical properties of such clouds but, it unequivocally runs into the problem of treating clouds as 3D objects. In this work we will show results of measurements of cloud side radiances performed during the CLAIM 2005 experiment in Brazil and the modeling effort involved in retrieving the vertical profile of cloud microphysical and thermodynamic properties of convective clouds from this data set. The retrieved vertical profile of cloud effective radius was performed on the experimental data set using 3D radiative transfer calculations by SHDOM and Monte Carlo simulations. The results show details of the microphysical structure of the clouds that cannot be obtained today by other experimental methods.

Keywords: cloud side, 3d

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JMS025 **Poster presentation** **1470**

The Meteor Crater during METCRAX - a case for 3D radiative transfer modeling

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C. David Whiteman

The diurnal evolution of stable boundary layer structure was studied in the idealized topographic basin of Arizona's Meteor Crater. This crater, which is 1.2 km in diameter and 165 m deep, was formed by a meteorite impact 50,000 years ago. The crater and its surroundings were heavily instrumented during October 2006 with a variety of in-situ and remote-sensing meteorological equipment to study the relative importance of the different processes involved in cold-air pool evolution, including the divergence of longwave radiation. The observational equipment included 3 tethered balloon sounding systems, a rawinsonde sounding system, 60 temperature data loggers, 7 flux towers, 7 surface radiation budget stations and a radiative flux divergence tower. From these observations, hourly three-dimensional datasets of both the temperature and the humidity field within the crater have been compiled for clear sky days. This poster introduces the three-dimensional dataset and discusses the radiative processes involved in cold-air pool evolution. Plans to use the available dataset to drive a 3-dimensional radiative transfer model for the unique crater topography are discussed. Such model calculations will help to assess the importance of radiative processes in cold-air pool evolution in the crater and in other topography of similar scale.

Keywords: topography, flux divergence

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JMS025 **Poster presentation** **1471**

Determination of carbon dioxide concentration from spectroscopic measurements for cloud contaminated pixels

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Alexander Uspensky

Using mathematical modeling of measurements by the SCIAMACHY spectrometer on the ENVISAT satellite the method of CO2 concentration determination under conditions of the semi transparent and broken clouds has been developed. The method is based on simultaneous measurement of spectral reflection coefficients for the underline surface +atmosphere system within absorption bands of oxygen (near 760 nm) and carbon dioxide (near 1600 nm) for several channels pairs specially selected within each band. Criterion of their selection is the equality of change ranges of relative optical thickness of O2&CO2 absorption or their linear combinations by transition from clear sky conditions to cloud cover ones. There is given, for example, concrete choice of such channels pairs and accuracy estimates of CO2 concentration determination achievable at their use under different atmospheric conditions. It is shown, that under cloudy conditions, including cases with cumulus clouds, accuracy of the method equals to 12 % depending on cloud amount and the Sun zenith angle.

Keywords: co2, sciamachy, cumulus

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JMS025 **Poster presentation** **1472**

Ambiguities in using zenith radiances and downward fluxes for assessing cloud properties above green vegetation

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Alexander Marshak, Tobias Zinner

The retrieval of cloud properties using ground based remote sensing techniques is a particularly challenging task for optically thin clouds, especially as these clouds have often broken structures. One recently presented and promising method to retrieve cloud optical thickness uses zenith-sky radiances in the red (670nm) and the NIR (870nm) spectral region, measured at locations surrounded with green vegetation. This "REDvsNIR" technique provides also an estimate of the cloud cover, which makes the method largely insensitive to non-overcast cloud situations. Intercomparisons between approved cloud optical thickness retrieval methods and the REDvsNIR technique under various cloud conditions showed good agreements. However, to make this technique more robust, we investigate the possibility of combining radiances and fluxes using 3D radiative transfer simulations. With the use of spatially high-resolution cloud fields (15x15m2), constructed using measured radiances from aircrafts, we show how we assess and improve the retrieval technique under realistic cloud conditions.

Keywords: ground based remote sensing, cloud optical thickness, 3d radiative transfer

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JMS025 **Poster presentation** **1473**

Aerosol-cloud radiative interaction in cumulus cloud fields in Brazil

Dr. Guoyong Wen
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Alexander Marshak, Robert F. Cahalan, Lorraine A. Remer, Richard Kleidman

3D aerosol-cloud interaction is examined by analyzing two images containing cumulus clouds in biomass burning regions in Brazil. The research consists of two parts. The first part focuses on identifying 3D cloud impacts on reflectances for the pixels selected for the MODIS aerosol retrieval based purely on observations. The second part of the research combines the observations with radiative transfer computations to identify key parameters in the 3D aerosol-cloud interaction. We find that 3D cloud-induced enhancement depends on the optical properties of nearby clouds as well as on wavelength. The enhancement is too large to be ignored. Associated bias error in 1D aerosol optical thickness retrieval ranges from 50% to 140% depending on wavelength and the optical depth of nearby clouds, as well as aerosol optical thickness. We caution the community to be prudent when applying 1D approximations in computing solar radiation in clear regions adjacent to clouds, or when using traditional retrieved aerosol optical thickness in aerosol indirect effect research.

Keywords: 3 dimension, aerosol, cumulus

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JMS025 **Poster presentation** **1474**

Solutions for global warming control and experimental laboratory validation

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Università di Perugia CIRIAF

Cotana

Greenhouse gases (primarily carbon dioxide) have rapidly increased over the last century mainly because of massive usage of fossil fuel for energy production; a direct consequence is the increase of average low atmosphere temperature. IPCC (Intergovernmental Panel on Climate Change) 4th assessment report predicts that continued greenhouse gas emissions (current rate) would cause at the end of the 21st century a globally-average surface warming between 1,8 and 4°C. The only meaningful greenhouse gases reduction attempt is represented by Kyoto Protocol; the emissions reduction fixed by such protocol is however insufficient to solve global warming problem. Furthermore, most effective solutions for carbon dioxide capture like chemical absorption processes or physical solvent processes are still too expensive and hard to be realized. An innovative simple proposal for global warming control is here proposed which is based on earth surface albedo enhancing by means of laying reflecting surfaces. The proposal includes an original relation (patent n. PG 2006 A 0086) between reflecting surfaces extension and corresponding average temperature decrease; furthermore a ratio between greenhouse gases emission, in terms of equivalent carbon dioxide, and reflecting surfaces extension is also introduced. Many solution for realizing reflecting surfaces are proposed: roof painting, road and low value areas painting, floating white colored island and artificial salt lakes. An experimental laboratory apparatus has been realized for modeling earth surface, atmosphere, space and sun in order to reproduce the phenomena which determine temperature changes on the earth surface when a modification of surface reflection coefficient occurs.

Keywords: refecting, white

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JMS026 **1475 - 1503**

Symposium
Ice Cores and Climate (UCCS Symposium hosted by IAMAS)

Convener : Prof. Dorthe Dahl-Jensen

Ice Cores drilled though ice on ice sheets and glaciers contain records on the past climate reaching as far back as up to 900.000 years. Ice core analyses have developed during the last decades and the span of parameters measured on the modern ice cores has expanded. The high resolution records from the ice cores thereby are some of the best sources we have in palaeo-climate research to manifest the full dynamics of the coupled atmosphere-ocean-ice climate system. The aim is to present climate related ice core records from the ice sheets and glaciers both from the Arctic and Antarctic regions but also from those regions where ice is rapidly disappearing and the need to obtain ice cores before the ice is gone is urgent

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JMS026 **Oral Presentation** **1475**

The effects of climatic forcing on the binge-purge oscillation of the Laurentide Ice Sheet: a conceptual modelling study

Mr. Hans Christian Steen-Larsen
Niels Bohr Institute, University of Copenhagen Centre for Ice and Climate IAMAS

Dorthe Dahl-Jensen

Heinrich Events are observed as six discreet layers of sediment in deep-sea cores from the Eastern North Atlantic. These layers consist of ice-rafted debris. The source area for these layers has been identified as Eastern Canada. It is widely recognized that the cause of these layers is surges of the Laurentide Ice Sheet, but the cause of these surges is still debated. A likely explanation for the surges by the Laurentide Ice Sheet is that the bed of the ice sheet reached the melting temperature thereby reducing the basal shear stress and letting the ice flow velocity increase. Several studies have shown that the oscillation of the Laurentide Ice Sheet, also known as binge-purge oscillations, could occur through an internal dynamic without any external forcing. To examine the effects of time-dependent temperatures and accumulation rates on the timing of the surges of the Laurentide Ice Sheet we use a 1-D thermo-mechanical model. The model is coupled to the profile of the ice sheet which is governed by the laws of a perfectly plastic solid. We show that external forcing, in terms of temperatures and accumulation rates, is important to include in simulations of the oscillations of the Laurentide Ice Sheet. By linearly coupling the equilibrium line to the temperature record obtained from the GRIP ice core and by having a time-dependent accumulation rate it is possible to explain the Heinrich Events by looking at the basal condition of the Laurentide Ice Sheet when reaching its melting temperature. The two constants that couple the equilibrium line with the temperatures are tuned such that the bed of the ice sheet reaches its melting temperature approximately at the same time as the Heinrich Events have been observed in deep sea sediment cores from the North Atlantic. Furthermore, we show that the timing of the surges of the ice sheet are very sensitive to the snow accumulation rate. This highlights the important role of the surface temperature and the accumulation rate as a means of forcing the time and strength of the Heinrich Events. Even though this is a simple model we find that the oscillation of the Laurentide Ice Sheet can be explained by internal oscillations in the ice sheet modulated by external conditions. This sheds light on the mechanism that caused the Wisconsian Laurentide Ice Sheet to surge with irregular intervals causing very significant climate changes in the North Atlantic during the last glacial period. Furthermore this study shows the importance of including a temporal surface temperature and accumulation rate when using more complex models.

Keywords: heinrich events, laurentide ice sheet

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JMS026 **Oral Presentation** **1476**

Link between climate shifts and geomagnetic field excursions

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The link between global-scale climate shifts and excursions of the geomagnetic field during the past 400,000 years is discussed. Time coincidence of the Earth surface temperature jumps, drops in content of stratosphere dust and increases in 10Be concentration in ice core sheets is revealed. Our model when during its excursions the geomagnetic field loses a lot in its module value making the penetration of charged particles (CP) of solar wind, galactic cosmic rays and radiation belts into the Earth atmosphere possible is proposed. If the excursion is starting in glaciation environments produced by stratosphere dust which is backscattering the incoming solar radiation then interacting with atmosphere nuclei CP are destructing stratosphere aerosols. The following atmosphere transparency enables the Sun rays to warm the Earth surface giving rise to global climate warming. If the excursion is starting in transparent atmosphere conditions then the penetrating CP generate stratosphere aerosols and eventually the solar radiation shielding i.e. climate cooling. Revealed to be synchronous with excursions of the geomagnetic field the events in Human evolution are apparently related to climate shifts.

Keywords: climat shifts, geomagnetic excursions

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JMS026 **Oral Presentation** **1477**

A potential high-elevation ice-core site at MT. Elbrus, Caucasus

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The Mt. Elbrus volcano constitutes a unique location in the mid-latitudes of the Northern Hemisphere for obtaining non-polar paleo-records from ice cores. Nevertheless, no ice-core record with meaningful paleoclimate information has yet been obtained from Caucasus. Two shallow ice cores, 21.4 and 9.5 m depth, have been recovered on the Western Firn Plateau (5100 m a.s.l.) and on the eastern summit (5640 m a.s.l.) of Mt. Elbrus, Central Caucasus in 2003 and 2006. First ice core has been analyzed for stable oxygen (18O) and hydrogen (2H) isotope composition. Firn density has been measured at the drilling site and ranged from 210 kg/m3 at the upper part of the ice core to 680 kg/m3 at 21.4 m. Temperatures were measured in the borehole and changed from -11.5C near surface to -17C at 10 m depth. Distinct seasonal fluctuations of stable isotope composition have been defined in ice core. Mean annual value of snow accumulation according to isotopic oscillations is 1200 mm w.e. Minimum values of the δ18O and δD were -28 and -206. High correlation between δ18O and δD has been revealed and the meteoric water equation (δD = 8.0071 δ18O + 15.173) has been obtained for the first time for high elevation of Central Caucasus. Detailed stratigraphic record indicates absence of surface melting and ice layer availability in firn pack. Radio-echo sounding measurements show that ice depth ranged from 70 m along the edges of the plateau to 240.8 m in the central part. Preliminary assessment of the glacier age on the base of ice depth, surface accumulation, temperature distribution, and bottom relief show 700-800 years near bedrock. The record from 9.5 m summit core reveals considerable wind scouring. The record indicates that Western Firn Plateau of Mt. Elbrus is the best site for ice-core studies in Caucasus. This work is a part of research supported by the Russian Foundation for Basic Research grant 07-05-00410.

Keywords: ice core, caucasus, elbrus

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JMS026 **Oral Presentation** **1478**

Magnetic properties of some glacial and interglacial samples from the EPICA-Dome C ice core

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We measured the isothermal remanent magnetization (IRM) and coercivity of remanence (Hcr) of fine magnetic particles included as dust in ice samples from the EPICA ice core (East Antarctica). Magnetic coercivity and dust magnetization of glacial and interglacial samples shows a significant difference that suggests different magnetic properties (grain sizes or compositions) and thus provenance of the dust. Comparison of dust magnetization values to mass magnetization of possible source area samples suggests that sporadic contributions of dust from Antarctica to the EPICA ice core cannot be excluded for interglacials. As already observed in Greenland ice samples, this correlation also reveals a background magnetization, which appears to be essentially constant from glacial to interglacial intervals. Measurements performed at different temperature (77K and 256K) reveal the presence of superparamagnetic particles that, due to their ultra-small size (< 20 nm), would pass unnoticed in granulometric analysis.

Keywords: antarctica, ice cores, magnetism

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JMS026 **Oral Presentation** **1479**

Inter-annual variability of d-T relation at Dome Fuji, east Antarctica

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Relationship between stable isotopes in accumulated snow and temperature (d-T relation) is one of the most fundamental indexes for Antarctic ice core studies. To date, geographical relationships are adopted to interpret a temporal ice core record. However, d-T relation in accumulated snow is determined not only by d-T relation in fallen snow but also precipitation seasonality and/or timing. We have little information about inter-annual variability of d-T relation associated with precipitation seasonality and/or timing even in the present climate condition. Stable isotopes and amount of daily precipitation at Dome Fuji, east Antarctica were collected throughout 2003. A precipitation weighted average field of geopotential height using NCEP/NCAR reanalysis data suggests that high-pressure field at Indian Sea supplied vapor into inland Dome Fuji. The author attempts to reconstruct the daily amount of precipitation at Dome Fuji since 1971 using geopotential height, specific humidity and temperature of the reanalysis data. The calculated differences between precipitation weighted and arithmetic averaged annual temperatures show a significant inter-annual variability of d-T relation during the last 35 years. This study shows a large uncertainty of d-T relation even in the present days.

Keywords: stable isotopes, precipitation reconstruction, interannual variability

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JMS026 **Oral Presentation** **1480**

Ice Cores and Self-organizing Maps: A Study of Recent Climate in Greenland

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Recent years have seen a large increase in the availability of high-quality ice cores from the Greenland Ice Sheet (GIS) and the subsequent development of many new high-resolution proxy climate records. Here we apply a relatively new, nonlinear approach based on self-organizing maps (SOMs) to study the spatial and temporal variability seen in records from 58 ice core sites from part or all of the period 1957-2002. SOMs provide an unsupervised classification of complex geophysical data sets, e.g., time series of the atmospheric circulation or sea-ice extent, into a fixed number of distinct generalized patterns, or modes, that represent the probability density function (PDF) of the input data. These patterns collectively provide a nonlinear classification of the continuum of the PDF into a two-dimensional, spatially organized grid form. In contrast to principal component analysis, SOMs do not force orthogonality or require subjective rotations to produce interpretable patterns. Early results from an analysis of annual accumulation show that the SOM readily captures the high spatial diversity seen in climate records from the GIS, including nonlinear gradients in latitude and elevation. For example, sites in the northern and central regions (e.g. Humboldt, NASA-U) tend to be unrelated to sites in the south and east (e.g., Das1, STUNUA). Sites within the south/southeast also show richer patterns of variability than simply above or below average accumulation. Understanding these relationships, and the spatial complexity of Greenlands climate, is key to improving our ice core-based reconstructions of past climate and projecting possible future changes in the GIS. Another feature of the SOM analysis algorithm is its robustness in the presence of incomplete input data. Part of this project is to study the practical sensitivity of the SOM-derived patterns as the number of sites and length of record changes in the input. This also gives insight to which sites matter the most in understanding ice sheet history. When combined with ongoing SOM-based analyses of the atmospheric circulation, we anticipate new insights into the complex climate of this region, including relationships with phenomena such as the North Atlantic Oscillation/Arctic Oscillation.

Keywords: greenland, self organizing maps, ice cores

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JMS026 **Oral Presentation** **1481**

A 720 kyr ice-core chemistry record from Dome Fuji, Antarctica

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Members Of The Dome Fuji Ice Core Research Group

Ice core drilling at Dome Fuji, Antarctica reached a depth of 3035.22m in January 2007. In April 2006, the core from the depth interval between 2400m and 3028m was transported to Japan. The samples from this depth interval have been being processed and analyzed at National Institute of Polar Research, Japan for stable isotopes, ion chemistry and insoluble particles. Here we report the current status of the ongoing analyses and the latest results from the Dome Fuji core. The oxygen isotope profile, compared with the Dome C deuterium profile, suggests that the depth 3028m goes back to 720,000 years ago, which corresponds to MIS (Marine Isotope Stage) 17. Analysis carried out so far confirms that the new Dome Fuji core provides us with reliable climatic and environmental record at least down to 3028m depth (i.e. back to 720,000 years ago). As was found at Dome C, the isotope record at Dome Fuji shows smaller amplitude of glacial-interglacial variability before MIS 11. The interglacials prior to MIS 11 are colder than later ones. As well as the glacials after MIS 9, which have been covered by the first Dome Fuji core drilled down to 2053m in 1996, the glacials prior to MIS 9 show millennial-scale climate variations. The interglacial MIS 15 is interrupted by a glacial-like cold period, which also shows millennial-scale climate variability. Throughout the last 720,000 years, fluxes of non-sea-salt Ca2+ (proxy for dust) and sea-salt Na+ (proxy for sea-salt) are high during glacials and low during interglacials. Fluxes of these ions and their orbital-scale variations are very similar to those at Dome C, which suggests uniform ion fluxes and their variations overEast Antarctica on orbital time-scales. On shorter time-scales, however, non-sea-salt Ca2+ fluxes show significant regional differences between Dome Fuji and Dome C. On the other hand, fluxes of sea-salt Na+ do not show much regional differences between these two sites even on shorter time-scales.

Keywords: dome fuji, deep ice core, 720000 years

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JMS026 **Oral Presentation** **1482**

Investigating a Dansgaard-Oeschger warming evidence for a tropical precursor?

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Large and abrupt temperature oscillations during the last glacial period, known as Dansgaard-Oeschger (DO) events, are clearly observed in the Greenland ice core record. Here we present a new high-resolution chemical (2 mm) and stable isotope (2 cm) record from the European North Greenland ice core project (NGRIP) ice core at the onset of one of the most prominent DO events of the last glacial, DO-8, observed ~38,000 years ago. The unique sub-annual resolution NGRIP record provides a true sequence of change during a DO warming with annual layer counting used to determine the exact duration of the transition, which is free of dating uncertainties. The continental ions, indicative of the East Asian monsoon system, are the first to change, followed by the snow accumulation, the moisture source conditions and finally the atmospheric temperature in Greenland. The sequence of events, indicating atmospheric and oceanic source and circulation changes preceded the DO warming by several years, imply that this abrupt warming was triggered outside of the North Atlantic.

Keywords: ngrip, dansgaard oeschger events, high resolution record

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JMS026 **Oral Presentation** **1483**

Dome Argus (Antarctica): prospect for 1.5 million year old ice

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In 2004/05, a 110 m long ice core was recovered at Dome Argus, the highest ice feature in East Antarctica. We calculated a very low late Holocene accumulation rate of 1.25 to 1.5 cm H2O/yr using ice core bubble methane, air isotopic composition, firn density measurements and densification modeling. This is only two-thirds of the lowest accumulation rate at Antarctic inland ever reported. When considering additionally a local annual temperature -58.5 and an ice thickness over 3050 m, the Dome Argus area should be a priority target for the ice core community to get access to ice possibly as old as 1.5 million years.

Keywords: dome, argus, ice core

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JMS026 **Oral Presentation** **1484**

Heinrich and Dansgaard-Oeschger Events recorded in atmospheric oxygen isotopes

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The oxygen-18 content of molecular oxygen in the atmosphere (d18Oatm) is known to vary on orbital timescales, especially with the precession period (about 20 kyr). The cause is thought to be a combination of 1) ice sheet growth and consequent variation of O-18 in seawater, the original source of all substrate H2O used for photosynthetic O2, and 2) changes in the biogeochemical fractionation of O2 relative to seawater, known as the Dole Effect. Because the turnover time of O2 in the atmosphere is ~1000 years, variations on shorter timescales have not been expected and previous studies have not searched for them. Here we present a new high-resolution record of d18Oatm from the Siple Dome ice core, Antarctica, covering the past 95 kyr. The record shows distinct millennial-duration positive anomalies in d18Oatm, coincident with Heinrich and long cold DO events in the northern hemisphere. Some shorter events such as the Younger Dryas and 8k event also show a clear anomaly. Importantly, the positive anomalies occur during known periods of sea level rise in some cases (Heinrich Event 1, Younger Dryas), suggesting that they cannot be due to changes in seawater O-18 but rather must be changes in the Dole Effect. The records bear strong resemblance to Asian speleothem O-18 records, which have been interpreted as monsoon strength indicators. Monsoon precipitation is typically depleted by several per mil in O-18, due to the amount effect. Leaf water O-18 is likewise depleted during monsoons due to high relative humidity. Photosynthesis in monsoon regions thus produces isotopically depleted O2. We speculate that the millennial-scale anomalies in d18Oatm are caused by the abrupt reductions in northern hemisphere monsoons that accompanied Heinrich and cold DO events. Because atmospheric oxygen is produced by photosynthesis over most of the globe, these findings underscore the geographically widespread extent of the hydrological impacts of abrupt climate change. They also warn that future abrupt climate change may rearrange rainfall patterns, with implications for agriculture and society.

Keywords: atmospheric dioxygen, dole effect, ice cores

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JMS026 **Oral Presentation** **1485**

Dome A : a potential site for obtaining ice-core older than 1.0 Ma

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Dome A is a point of international scientific interest because, as the summit of the Antarctic ice sheet, it is a location where the ice layers are deposited sequentially and compressed in-situ without disturbance by ice flow. Hence it is a site where very long and undisturbed ice-core paleo-climate records might be obtained. The International Trans-Antarctic Scientific Expedition (ITASE) , a program sponsored by SCAR and IGBP PAGES, aims to determine the spatial and temporal variability of Antarctic climate. As a part of ITASE, the surface investigation at Dome A was carried out during the 21st Chinese National Antarctic Research Expedition (21st CHINARE), 2004/05 austral summer. No ground-based scientific investigationshave been undertaken at this site before then. Investigations by 21st CHINARE at Dome A include: (1) Relaying an automatic weather station to measure snow accumulation rate and meteorological characteristics. (2) Radio sounding radar to detect ice layers and ice thickness. (3) drilled an ice core with length 110 meters. (4) Snow pit for determine recent accumulation rate. (5) GPS survey for ice motion and surface mapping. It shows that the mean air temperature at Dome A in 2005 is -58.5C water depth per year, respectively. Snow density and measured CH_4 mixing ratio shows that the close-off depth at Dome A is around 100 meter below surface. Radio-sounding radar shows that there are locations where ice thicknessare bigger than 3050 meters. By comparing the isochronous layers between Dome A and Dome Fuji, the ice thickness at Dome A is approximately 300 meters larger than Dome Fuji, where the bottom ice is believed to be at least 1 million years old. Low accumulation rate, low temperature and thick ice layers and probably weak geothermal flux between ice /rock interface (no underglacier lake) are the favorable conditions for obtaining old ice. Dome A satisfies these conditions thus is a potential site for such purpose. Ice cores older than 1 million years are expected to be a robust tool to explain the climate transition from 40,000 years' cycle to 100,000 years' cycle occurred 1 million years ago.

Keywords: dome a, ice core, palioclimate

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JMS026 **Oral Presentation** **1486**

Ice core records from mid latitudes in South America, a needed link between the Tropics and Antarctica

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Long glaciological climate records exist already from ice drillings in tropical and subtropical latitudes in South America, and also in Antarctica, but there is a real data gap between 30S and 60S. The high summits located in the mid-latitude Andes present unique sites in the Southern Hemisphere for retrieving meaningful paleoclimate records. This work will show a summary of recent shallow firn core results obtained in southern South America from Cerro Mercedario (3158S, 7007W, 6100 m a.s.l., 13.5 m core); Monte San Valentn (46 36S, 7320W, 3750 m a.s.l., 16 m core); and Cerro Gorra Blanca Norte, (4908' S, 7303' W, 2300 m a.s.l., 5 m core). Preliminary analyses of deeper cores drilled at Cerro Mercedario (104 m core) and the northern plateau of Cerro Mariano Moreno (4916S, 7321W, 2600 m a.s.l., 50.6 m core) will be presented, as well as ongoing plans for deeper drilling at Monte San Valentn. The climatic interpretation of these ice cores should add important data of both time variations and spatial variations along a north-south gradient at mid latitudes in the Southern Hemisphere for the last few centuries.

Keywords: ice cores, south america, mid latitudes

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JMS026 **Oral Presentation** **1487**

A new sub-annually resolved accumulation series from Law Dome

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Law Dome, in coastal East Antarctica, is a relatively low-latitude site (6646S) with a strong maritime climate, dominated by cyclonic precipitation which produces high snow accumulation rates and very well-resolved ice core records. These records exhibit strong maritime influence with links to climate at mid-latitudes. The annual accumulation record has a strong correlation ($r>0.6$) with sea-level pressure across Southern Australia. Here we present a new technique for partitioning the annual accumulation signal into nominal summer and winter series. The summer component is identified with the accumulation in which the sulphate/chloride ratio exceeds that in sea-water; the remaining portion of the year, during which sea-salt dominates the sulphate budget, is the nominal winter component. Sulphate from sporadic volcanic input can be excluded or treated separately. This marker is found to exhibit a sharp transition that gives a reliable identification of onset and termination of biogenic summer sulphate input. The winter accumulation, defined in this way, comprises ~54% of annual accumulation over the last century but exhibits higher variability than summer accumulation. We explore the interpretation and calibration of this new proxy and investigate the connections with mid-latitude meteorology.

Keywords: ice core, holocene, accumulation

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JMS026 **Oral Presentation** **1488**

At What Depth is the Eemian Layer Expected to be Found at NEEM?

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As of yet, no unbroken record of the Eemian interglacial period, 115-130 ka BP, exists from Greenland. However, a new ice core drill site, NEEM, has been suggested at 77.480N, 50.957W in North Greenland. Radio echo images and flow model investigations indicate that an undisturbed Eemian record may be obtained at NEEM. In this work a two-dimensional ice flow model with time dependent accumulation rate and ice thickness is used to estimate the depth of the Eemian layer at the new drill site. The model is used to simulate the ice flow along the ice ridge leading to the drill site. Unknown flow parameters are found through a Monte Carlo inversion of the flow model constrained by observed isochrones in the ice. Preliminary results indicate that the ice from the Eemian period is approximately 100 m thick and that the base of the layer is located approximately 200 m above bedrock.

Keywords: ice flow, eemian, monte carlo

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JMS026 **Oral Presentation** **1489**

Impact of accumulation hiatus in the firn at a megadunes site

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Gas transport in the porous and permeable firn from polar regions plays a crucial role in determining the ice core record of past climate change. Chemical species migrate through the firn due to diffusion, as well as convection induced by wind movement. These processes are especially important to consider in low accumulation rate regions, where the long residence time the firn spends at the surface leads to significant alteration of both the firn grains and the gases found within the pore structure. Firn cores retrieved from a megadunes area of East Antarctica reveal the physical properties of the core in the top 30 meters vary significantly with depth due to dune migration. Megadunes are low-amplitude (2 to 8 m), long wavelength (2 to 5 km) bands with perceptible but low accumulation (less than 40 mm w.e. a-1) and accumulation hiatus within several kilometers proximity, as determined by remote sensing, surface feature classification, and GPR (ground penetrating radar) profiling. While the leeward face of a megadune experiences a hiatus in snow accumulation, the windward face does experience accumulation. Differences in grain size, thermal conductivity, and permeability across a megadune profile are due to spatial accumulation variability in the absence of significant microclimate variations. Relatively small differences in accumulation rate (less than 40 mm w.e. a-1) result in large differences in physical properties. The differences in physical snow structure between low-accumulation areas and accumulation-hiatus areas are sufficiently distinct so that evidence of past accumulation hiatus should be observable in the physical and chemical properties of an ice core record.

Keywords: megadunes, firn, hiatus

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JMS026 **Oral Presentation** **1490**

New measurements and modeling of oxygen and nitrogen isotopes of nitrate in Greenland, and implications for ice core interpretation

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The magnitude of natural variability in atmospheric concentrations of reactive nitrogen species (NOx = NO + NO2) and oxidants (O3, OH) remains poorly constrained. Limitations in the interpretation of applicable proxies for these atmospheric species have hindered quantitative determination of changes observed in ice cores, particularly on glacial-interglacial timescales. Better understanding of both NOx and oxidant concentrations during glacial-interglacial transitions is essential for closure of the global methane budget and a better understanding of the biosphere-atmospheric chemistry response to climate change. Recent work on nitrate isotopes (d18O, d15N, and D17O[= d17O -0.52*d18O])) in ice cores has demonstrated promise for improving our understanding of changes in NOx sources as well as changes in oxidation chemistry. Our ice core measurements to date suggest that d15N declines and that both D17O and d18O increase (on average) in the last century. These changes likely reflect both the differing isotope ratios of HNO3 sources (i.e., industrial vs. biological NOx production), and the increase in atmospheric ozone. Our studies seek to improve quantitative interpretation of nitrate isotopes in ice cores through direct atmospheric measurements, snowpit measurements, and modeling. Here, we focus on measurements of nitrogen and oxygen isotopes from a snowpit at Summit, Greenland, and their interpretation in the context of local and global photochemical models. Measured values of nitrate D17O range from 24.7 in summertime to 33.0 in wintertime, while model results show a larger range (18.9-31.5). Agreement between observed and modeled results is excellent for winter, when O3 oxidation pathways dominate. The large discrepancy between summertime box model results and measurements of nitrate D17O is best explained by horizontal advection of nitrate from oceanic air masses, an explanation supported by results of a 3-D global chemical transport model. These results indicate that nitrate D17O in Greenland is representative of the atmosphere on at least a regional scale (i.e. it is not dependent only on local conditions at Summit).

Keywords: nitrate, isotopes, greenland

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JMS026 **Oral Presentation** **1491**

Talos Dome Ice Core Project. A new deep drilling in East Antarctica peripheral dome

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Talos Dome Ice Core Project (TALDICE) is an International project (Italy, France, Germany, Switzerland and United Kingdom) for provide a new ice core from Talos Dome (TD: 72°48'S, 159°06'E, 2316 m a.s.l., mean accum. 80 kg/m2 per year, about 290 km from Ross Sea and southern Ocean), and developed in a framework of European Project for Ice Coring in Antarctica (EPICA) and International Partnership in Ice Core Science (IPICS). Ground penetration radar measurements estimate the bedrock at around 1550 m depth, in a semi-flat area that permits to assume low stratigraphical disturbance at the bottom, with a bottom age of around 150 Kyrs. The TD camp was established during the 2004-05 season whit the digging of the science trench and the casing of the first 100 m of hole, and during 2006-07 season the ice core drilling reach the 1300 m depth. Stable isotope, gases, chemistry and dust measurements will be done in discrete subsampling, and continuous flow analyses (CFA) and fast ion-chromatography (FIC) measurements were performed in the AWI-Bremerhaven laboratories. Located in the Northern Victoria Land, TD is an East Antarctic peripheral dome that permits to investigate sea-ice influence on the East Antarctic plateau, and the atmosphere-ocean-ice relationships.

Keywords: ice core, paleoclimatology, atmospheric variability

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JMS026 **Poster presentation** **1492**

Algal biovolume in FIRN/ICE cores of the Chilean Lake District

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Firn/ice core analysis in temperate glaciers is complex due to meltwater percolation which results in strong mixing of chemical species and stable isotopes, effectively masking the seasonal/annual signals. Due to their larger size, microalgae are less affected by water percolation, as is shown by existing studies in glaciers of the Himalayas, North America and Patagonia. Microalgae growth occurs at the glacier surface during the melt season (spring-summer), when dissolved nutrients and light are maximum, and decay with the onset of autumn, when the glacier surface layer freezes and starts to be covered by a thick layer of several metres of seasonal snow, preventing microalgae growth. Microalgal biovolume is thus a potentially successful method for determining climate proxy records in temperate glaciers. Here we describe the first study to analyse algal biovolume in glaciers of the Chilean lake district (40-41S). Three firn/ice cores were collected: one at the summit of the glacier at Volcn Osorno (2652 m a.s.l.) and two at the glacier of Volcn Mocho-Choshuenco (one in the accumulation area at 2000 m a.s.l. and one at the summit at 2422 m a.s.l.). All cores were drilled during late spring, in November of 2005. The results show clear seasonal signals of algal biovolume and pollen abundance, allowing to estimate the annual mass balance. Protozoa (Tecameba Trinema spp.) were found in the cores as well, which enhances the seasonal interpretation obtained by means of microalgae and pollen. Results of chemical species are also presented, as well as basic physical parameters of firn density and concentration of ice lenses. This study confirms the potential of biological species as paleoindicators of environmental and climatic conditions.

Keywords: microalgae, chilean lake district, firn ice cores

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JMS026 **Poster presentation** **1493**

Does part of the deuterium/hydrogen rations in Earth come from the Sun?

Dr. Nivaor Rodolfo Rigozo

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Evangelista, H, Correia, E., Nordemann, D.J. R., Echer, E., Souza Echer, M. P.

A time series study was realized in order to identify dominant variability of deuterium/hydrogen ratios obtained in snow, firn and ice samples of an ice core from Lange Glacier (King George Island/Antarctic Peninsula, lat 6207'S, long 5837W). Periodicities were estimated by using classical spectral analysis (iterative regression) and multiresolution analysis. Solar signal was clearly identified in the spectral analysis through its periodicity of 11 years. The 11 yr band have been reconstructed from the parameters found in spectral analysis (amplitude, frequency and phase) and it was observed a high cross-correlation (r>0.6) between d2H and solar activity indexes (sunspot number, Aa index, protons high energy, >100 MeV). A (multiresolution) multi-resolution analysis has also been performed in all time series and has shown a high cross-correlation between this time series for the frequency level D2, D3, D4, D5 e D6. This suggests the hypothesis that part of the deuterium (2H) measured at Earth comes from the Sun as part of the solar wind or that high energy solar protons produce the deuterium in the earth atmosphere.

Keywords: deuteriumtimeseries, solarsignal, spectralanalysis

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JMS026 **Poster presentation** **1494**

Tephra study on a 3035.22-m deep ice core from Dome Fuji, Antarctica

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Polar Meteorology and Glaciology National Institute of Polar Research

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Tephras ejected to the upper troposphere and lower stratosphere during explosive volcanic eruptions are dispersed and eventually deposit onto the surface of ice sheets. Tephra layers found in ice sheet cores potentially provide coeval markers for the correlations through comparing their chemical compositions. Tephra studies on the ice cores, further, have a potential for identifying past explosive volcanism in the interhemispheric region, palaeoatmospheric loadings of the volcanic aerosols and their trajectories between the source volcanoes and coring sites, estimating the long- and short-scale relationship between volcanism and climate, the evaluation of relative accumulation rate changes, and analyses of englacial deformation and ice flow directions. Other advantages of the tephra studies include documenting a climate teleconnection between atmosphere and marine records by correlating between the ice and marine sediment cores using the tephra layers. A 3035.22-m deep ice core from Dome Fuji (7719S, 3942E, 3810 m a.s.l.), Antarctica, contained 34 visible layers colored from light yellow to dark brown. Tephra particles of a few tens of microns in size have been recovered from 21 visible layers in the uppermost 2500 m of the core. They have been used for quantitative analyses (SiO_2, TiO_2, Al_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, S and Cl) using a wavelength-dispersive electron microprobe analyzer (JXA8900, JEOL). Fourteen tephra layers belong to tholeiitic basaltic andesite to dacite, four to a calc-alkaline andesite and three to trachyandesite to trachyte. We expect to recover tephra particles from the other 13 visible layers in the deeper part of the core.

Keywords: icecore, domefuji, tephra

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JMS026 **Poster presentation** **1495**

Deuterium excess from a small Arctic ice cap: can we use this record in climate reconstructions of the past?

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We examine a profile of deuterium excess (d=δD-8δ18O) in a 121 m deep ice core drilled at the summit of the ice field Lomonosovfonna, Svalbard, at 1250 m asl in the spring of 1997. The core has been dated to cover the past 800 years with a sub-annual resolution back to beginning of the 19th century. It is commonly accepted that d in the final precipitation is a sensitive indicator of humidity and temperature at the sea surface. The analysis is thereby aimed at identifying the primary moisture source (if any) for the core location in order to link the variability of d with historical variations of the sea surface temperature in some remote area and find out whether the record of d can subsequently be used in climate reconstructions. The deuterium excess record exhibits pronounced multidecadal variations with generally negative anomalies of δ in the 1700s and positive in the 1800s. During the last 150 years d shows a significant negative trend, which is not in line with a general warming of the ocean surface observed during this period. Positive and negative composites of deuterium excess in DJF SLP anomalies have shown general tendency towards weakened zonal circulation in years with negative d anomalies. These results were further corroborated by the EOF analysis of the sliding 20 years correlations between the annual mean d, and DJF SLP. The analysis of DJF SSTs anomalies suggests that the location of the potential source area may vary in time, altering between the tropical and subtropical Atlantic and, probably, Pacific (positive d anomalies) and middle to subpolar latitudes in the North Atlantic (negative d anomalies). We hypothesize that weakening of zonal circulation accompanied by formation of the blocking high in the northern North Atlantic diminishes the role of remote tropical moisture sources leading to the negative d anomalies. Overall negative trend in d in the last 2 centuries is likely due to the warming of the (sub) polar latitudes (more evaporation) accompanied by intensified meridional circulation. This increases the role of more northerly moisture sources for the core site location. The analysis thereby does not support the conception of single stationary source for d in the profile and shows that d for this core is rather indicative of the type of circulation (more zonal or meridional) in a particular period of time. We therefore conclude that the use of the deuterium excess record from this ice cap in climate reconstructions is not straightforward.

Keywords: cryosphere, paleoclimatology

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JMS026 **Poster presentation** **1496**

30 years of snow deposition at Talos dome (Northern Victoria Land, East Antarctica): chemical profiles and climatic implications

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During the 2003-2004 Italian Antarctic Campaign snow pit samples were collected in Talos Dome (East Antarctica), a site characterised by a mean accumulation rate of 80 mm we/yr. The snow pit was dug in order to carry on a preliminary survey of the site chosen for a deep drilling in the framework of the TALDICE project and in order to test the capability of the site to give paleo-climatic and paleo-environmental information. Samples collected along the snow pit were analysed by ion chromatography and among all the measured species, MSA, nss-SO42- and NO3- showed a marked seasonal pattern, due to the seasonality of their sources with maxima of concentration occurring during summer and minima during winter. MSA and nss-SO42- arise from the atmospheric oxidation of dimethylsulphide (DMS), produced by phytoplankton metabolic activity which shows maxima during the summer season. While MSA originates only from marine biogenic activity, nssSO42- in Antarctica has other sources such as volcanic and crustal emissions. Indeed, excluding volcanic events, which are characterised by a sharp increase in sulphate for a relatively short time period (few years), the dominant source for nssSO42- at Talos Dome was found to be biogenic. Due to the relatively high accumulation rate, post-depositional processes are not able to delete the seasonal pattern of these three markers in the snow at Talos Dome, and for this reason they have been used to build a time-scale for the record. In this way a stratigraphic dating has been attempted for the whole snow pit, demonstrating to cover about 30 years of climatic history. In particular, species coming mainly from biogenic sources (MSA and nss-SO42-) have been investigated as potential markers for historical reconstruction of parameters linked to atmospheric and oceanic circulation such as Southern Oscillation Index (SOI). For the studied period, a good relationship between biogenic species, SOI index and sea-ice extent in the Ross Sea sector was observed suggesting that the ionic species, as recorded in Talos Dome snow and ice, can be used as markers for the reconstruction of the oceanic and atmospheric conditions in the past. Clearly, more research is needed to fully understand the temporal and spatial variability of the SOI-Antarctica relationship; however our results confirm a strong influence (especially for the 80s) of the ENSO on the chemical composition of the aerosol budget reaching the Talos Dome area.

Keywords: talos, snow pit, soi

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JMS026 **Poster presentation** **1497**

800 KYR of chemical stratigraphies from ion chromatographic data on epica-dome C ice core (East Antarctica)

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Ionic compounds measured along the ice cores are able to provide information about relevant environmental features such as marine biogenic productivity, sea ice extent, hydrological cycles of the surrounding continental areas, volcanic emissions and local to global transport efficiency. The chemical data from EDC (EPICA-Dome C, 75 06 S, 123 21 E; 3,233 m a.s.l.) ice core cover the last 740 kyr, corresponding to the last 8 glacial-interglacial cycles and represent the longest record ever obtained from an ice core. EDC ice core was analysed for ionic content (Na+, NH4+, K+, Mg2+, Ca2+, F-, MS-, Cl-, NO3-, SO42-) at high resolution (from 5 to 10 cm) along its whole depth (6-3190 m) by Ion Chromatography at the European laboratories belonging to the EPICA Chemistry Consortium. Here the data set provided by the laboratory of the University of Florence is presented.As a general feature, concentration vs. age profiles show a higher content of all the components in glacial periods compared to interglacials, as already observed in the 420 kyr record from Vostok ice core. This behaviour was usually ascribed both to increased source intensity and enhanced meridional transport; recently, on the basis of atmospheric circulation models, a more relevant role has been devoted to source areas changes (when post-depositional processes do not change a the original concentration of chemical markers in the snow layers). Due the dominance of dry deposition at Dome C, flux is more suitable than concentration to quantify the atmospheric concentration of the determined chemical parameters and to relate chemical content variations to source intensity or transport efficiency variations. Concentration and flux changes in EDC chemical profiles were interpreted as function of climatic and environmental variations. In particular, it was considered a distinctive climate change, the Mid-Brunhes Event, roughly corresponding to the transition between Marine Isotope Stage (MIS) 12 and 11 (about 430 kyr B.P.), which appears to be a boundary between two different climatic patterns. For most of the components, glacial/interglacial concentration ratios are different before and after MIS11 with large glacial-interglacial gaps after 430 kyr B.P. and smaller ones before 430 kyr B.P. Such a pattern appears to be weakened for those components (f.i. Cl-) which are affected by post-depositional phenomena and can be preserved in the snow layers only if the snow accumulation rate exceeds a determined threshold value. Except for these compounds, flux vs. age profiles generally confirm the concentration profiles with evident maxima in glacial and minima in interglacial periods and larger glacial-interglacial differences in the last 430 kyr. A spectral analysis statistical approach was attempted splitting the data set (concentrations and fluxes) on the basis of the Mid-Brunhes Event in order enlighten different periodicities in the two climatic patterns.

Keywords: ionchromatography, epica, mis11

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JMS026 **Poster presentation** **1498**

Modelling the Flow Induced Evolution of Fabric - A Study of Ice Cores from Central Greenland

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Polycrystalline ice undergoing deformation by intracrystalline slip develops a preferred orientation of c-axes (fabric), leading to anisotropic flow properties of the polycrystal. The evolution of fabric at GRIP and NorthGRIP is modeled using two different models for flow induced lattice rotation, Listers model and the Schmid-Boas model. The relation between the strain of the polycrystal and the strain of individual grains is determined from either Azumas flow law or from Sachs model in which deformation is only allowed by basal glide. The model results are compared with the observed fabric of the ice cores, using the Dansgaard-Johnsen model to relate the depth to the accumulated vertical strain. New measurements of the fabric in the GRIP ice core find a significant degree of orientation near the surface, matching observations on other dry-zone ice cores. Assuming an initial degree of orientation of 0.30 at GRIP, it is found that all the models overestimate the lattice rotations of grains by approximately 185% compared to observations. A correction to the Schmid-Boas model reducing the lattice rotation to 35% of the original value is proposed. The combination of this model and Azumas flow law, matches the observed fabric distributions at GRIP except in the deepest 300 m, without the inclusion of recrystallization models. A simple extension of this model to a more general stress state is presented and applied on the NorthGRIP core, showing very good agreement with observations in the upper 1400 m.

Keywords: fabric, flow, model

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JMS026 **Poster presentation** **1499**

Major elements geochemistry of the EPICA Dome C ice core dust over the last two climatic cycles

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Changes in climatic and environmental conditions (e.g. type and extent of vegetation cover and hydrological cycle) of continental surfaces can affect the geochemistry of the mineral assemblages of fine sediments able to be deflated from surface and transported in the atmosphere as windblown dust. Therefore, the chemical composition of dust deposited on polar ice sheets in the past can be used to investigate paleo-environmental modifications occurred at the dust source areas, as well as for the location of possible areas of dust production. The geochemical characterization of dust deposited during the last 220 kyr at Dome C (East Antarctica) obtained by PIXE (Particle Induced X-ray Emission) technique is here presented. Major and minor elements (Si, Al, Fe, Ca, Na, Mg, K and Ti) show a high co-variation with the dust record over the whole period, even if compositional differences among the three main cold stages investigated (LGM, MIS 4 and MIS 6), and differences in the compositional variability among interglacial (Holocene and MIS 5.5) and glacial periods come up from the study of the relative geochemical compositions. Comparison between polar dust and Southern Hemisphere PSAs (Potential Source Areas) sediments geochemical composition is here used for the individuation of dust source areas in different past climatic regimes; changes in the location of dust production areas are, in turn, indices of different environmental conditions at the source and/or different scenarios of atmospheric transport. At this purpose Dome C ice dust composition is here compared with data coming from literature and with data obtained by PIXE on the finer (< 5mm) fraction of sediments collected in the main SH-PSA: Southern South America, Australia, South Africa, New Zealand and Antarctic deglaciated areas. Results of this comparison point to a prevailing transport of glacial dust from the Southern South America regions, with a predominant role of the Pampas area - at least during LGM - even if evidences for a possible role of local sources cannot be ruled out. Conversely, interglacial dust shows a higher compositional variability that can be linked to environmental changes occurred differentially between glacial and interglacial stages in the continental areas and/or pointing to a possible different source mixing in which a second source (likely Australia) could have a large role.

Keywords: antarctica, ice cores, dust

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JMS026 **Poster presentation** **1500**

Environment response to climate changes from EDC ice core chemical stratigraphies. New insights by using sulphate as accumulation proxy marker.

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Continuous, high-resolution stratigraphies of stable isotopes and chemical compounds measured along Antarctic and Greenland ice cores revealed complex relationships between climate forcing and environment response, enlightening non-linear patterns and feedback processes. The behaviour of environmental and climatic markers in the glacial onsets and in the deglaciations deserves particular attention in order to understand the intensity and the direction of the climate-environment cause-effect relationships. Besides, a reliable estimation of size and trend of the accumulation-rate changes, occurred as a response to temperature forcing, allows evaluating variation in hydrological cycles of areas surrounding Antarctica . These changes heavily involve the environmental systems and represent the effects of complex feedback processes involving changes in sea level, marine and atmospheric circulation, cloud coverage, Earth surface albedo, load of atmospheric aerosols, wet area extension, and desertification. Here, we present high-resolution stratigraphies for the last 8 glacial cycles (about 900 kyr) of selected chemical species determined along the EPICA EDC ice core drilled at Dome C, East Antarctica (7506 S; 12323 E; 3233 m a.s.l.). Depth profiles of environmental markers (e.g., Na for sea spray, Ca for dust, MSA and nss-sulphate for oceanic phytoplankton activity) are compared to isotopic temperature profile (evaluated by dD) and accumulation rate, in order to evaluate possible leads and lags between climatic and environmental changes. Since accumulation-rate is a key-parameter in controlling concentration in ice of chemical compounds, we compared its profile by isotopic temperature (assuming that the accumulation rate changes in proportion to the derivative of the water vapour saturation pressure at this layer) with that resulting by using sulphate concentration as a proxy-marker. Indeed, recent evidences revealed that, during fast climatic changes, non-linear processes could affect the temperature-accumulation rate relationships. At Dome C, where dry deposition is the dominant scavenging process, sulphate concentration is affected mainly by changes in accumulation rate. In fact, sulphate depositional fluxes are quite constant in the time, revealing that intensity of its sources and transport processes feeding this component to ice sheet did not change in different climatic periods. Sulphate-accumulation rate profiles are compared with EDC chemical, dust and temperature profiles and with sea-level change records, as revealed by oceanic sedimentary cores. We enlighten differences in accumulation rate evaluated by dD or by sulphate, especially during the glaciation onsets. The sulphate-accumulation profiles seem to be more suitable in explaining spikes of dust during glacial maxima and show temporal trends congruous with changes in ice-cap growth, as revealed by changes in sea levels from benthonic isotopic records. Our findings show that accumulation rate changed slower as previously evaluated during glaciations, in part accounting for the long delay observed between temperature changes and variations in chemical-marker concentrations.

Keywords: antarctica, ice cores, chemistry

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JMS026 **Poster presentation** **1501**

Two Branches of Indian Monsoon and Their Boundary Revealed by Comparison of Accumulation Rate Recorded in the Dasuopu Ice Core from the Middle Himalayas with Meteorological Data

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Monsoon variability has profound impacts on water resources, human life, ecosystems and social economy. Climate variations, especially precipitation variations, usually display regional characteristics. To understand the regional characteristics in past precipitation variations has an important significance for the prediction of future climate. Accumulation rate in the Dasuopu ice core from the central Himalayas , where climate is mostly affected by Indian monsoon in summertime, is a good proxy for precipitation. By analyses of the variations in accumulation rate in the Dasuopu ice core and precipitations in all India over the past 150 years, it was found that the correlation is strongly positive between the accumulation rate and precipitation in the eastern part of India, while negative between the accumulation rate and precipitation in the western part of India, and the position separating these two areas with opposite correlations is located around 80 E. Based on the NCEP/NCAR Reanalysis Data, it was revealed that, to the east of this dividing limit, air mass mostly comes from the Bay of Bengal, and to the west of this dividing limit, from the Arabian Sea. These suggest that Indian monsoon has two branches, the Bay of Bengal branch and the Arabian Sea branch, and they affect summer climates in the east and west , respectively. Moreover, it was found that the limit of Indian monsoon extending northward might be situated at about 33 N in the Tibetan Plateau by comparison of accumulation rate record with the variations in precipitations in the Tibetan Plateau over the past decades and by analyses of wind directions in India and the Tibetan Plateau in summertime.

Keywords: ice core, monsoon, himalayas

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JMS026 **Poster presentation** **1502**

Fabric and microstructure evolution in the upper part of the GRIP, NorthGRIP and Dome C ice cores

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Recent ice sheet models take into account the anisotropy of ice, i.e. the fact that ice crystals in natural ice often show a preferred orientation. In the models it is often assumed that the fabric at the top of the ice sheet is close to random. In this study we present new and published profiles of fabric and microstructure in a large number of crystals from the upper 1000 m of the GRIP, NorthGRIP and Dome C ice cores as obtained with an automatic fabric analyzer. We show that in all three cores the fabric is strongly non-isotropic already at about 100 m depth just below the firn with the degree of orientation being 30-40%. This result is in contrast to previously published results that show an almost isotropic c-axis distribution at this depth.The GRIP site is located on a dome andthe fabric strengthens with depth and develops into a single pole fabric, whereas both the Dome C and in particular the NorthGRIP fabric develops into a vertical girdle. We discuss possible influences of grain size, impurity content, and seasonality on the fabric distribution. We obtain crystal size distributions with good statistics and compare them to various fit functions that may help us to understand the relative influence of grain growth and polygonization (rotation recrystallization) in this depth regime.

Keywords: ice core, ice crystal

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JMS026 **Poster presentation** **1503**

Variability of snow accumulation at the site with elevation of 7010m a.s.l. in Muztag Ata Mountain in Pamir Plateau

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During summer 2003, a 41-m firn and ice core with elevation of 7010m above sea level was drilled to determine annual accumulation rates at Muztag Ata peak in Pamirs Plateau. Using strong seasonally variation of oxygen isotopic of the core to define annual layers resulted in a 45-year record. Annual snow accumulation over the period of record averaged about 0.62m water equivalent. The snow accumulation was much higher during 1958-1975 than during 1976-2003. The accumulation decreased by a factor of two to three between 1958 and 2003. The snow accumulation experienced a notable shift in about 1975. This change is consistent with a simultaneous jump-like change in the 250 hPa geopotential height over southern Asian. A close negative correlation between the snow accumulation and the 250 hPa geopotential height suggests that the decrease in snow accumulation at the core site could be contributed by enhanced Southern Asian High over last decades.

Keywords: pamir plateau, snow accumulation

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JMS027 **1504 - 1533**

Symposium
Glacier Fluctuations in the Asian High Mountains (UCCS Symposium hosted by IAMAS)

Convener : Prof. Claudio Smiraglia

On the Asian high mountains effects of climate variations on glaciers and, thus, on mountain landscape and water availability are subject of increasing concern. 20th century mass loss of these glaciers is considered to contribute markedly to sea level rise. A high variety of different climate settings from the monsoon regions to westerlies to very dry Inner Asian circumstances give reason to complex patterns of the glaciers sensitivity. Effects of changing climate include mass balance variability, debris cover pattern, glacier surges, glacier terminus fluctuations, and glacier related risks. Current and future glacier fluctuations and impacts are addressed

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JMS027 **Oral Presentation** **1504**

Variability in the Extent of Glaciers in Response to Climatic Fluctuations in the Central Tien-Shan Mountains Since Late XIX century

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This research presents accurate evaluation of the recession eastern Terskey Alatoo glaciers, Tien Shan, central Asia, based on aerial photographs (1944, 1956, 1960, 1977, 1980 and 1988), 1:25 000 scale topographic maps, and the satellite images (Landsat ETM+, ASTER from 1999 to 2006) using ERDAS 9.0 software. In order to increase the accuracy in the identification of the moraines at the satellite and aerial images, field definition of LIA moraines position and all kind of published information about the front positions of glaciers in the end of XIX century was used. The glaciers under investigation are located on the eastern part of the Teskey Alatau range. We have estimated glaciers changes over the last 140 years. Only manual delineation of glaciers was used for all kind of images. For the most part of glaciers we had at least 8 outline positions since 1870s till 2006. Most glaciers in the study area exhibited shrinkage. On the average the glaciers in this area have retreated by 1000-600 m since the LIA maximum. Thus in the second part of XXth century (since 1950s), glaciers area has changed by about 9-11% comparing with 5-7% between 1880 and 1970s. In the last 10 years glaciers area decrease by 0.3 0.5 area %/year and the terminus retreat by 10-20 m/year. The temp of the wastage of glaciers in the Tien Shan has increased from the mid 1970s till the presents. Climate parameters was estimated using data from 10 nearest local meteorological stations and reanalysis data NCEP/NCAR and ERA-40. Monthly standartised time series were built for all meteorological data. Assessment of mass balance data from nearest glaciers support conclusions that there was significant changing of climatic conditions since mid 1970's. The study was supported by the ISTC grant # 2947 and INTAS YS Fellowship # 5742.

Keywords: glaciers, tien shan, climate changes

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JMS027 **Oral Presentation** **1505**

Assessment of Glacial mass balance using ASTER data and comparison with in-situ measurements: Chota Shingri Glacier, India

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Mass balance of alpine glaciers is considered important indicator of climatic variability and change. Deglaciation because of climatic variability is considered a world-wide problem and is particularly significant in Indian Himalayas where the glacier and snow cover provides up to eighty percent of the dry season flow to the Indus-Ganges-Brahmaputra river system .In India, Chota Shingri glacier in Himachal Himalayas has been identified as benchmark glacier for long term monitoring of mass balance. Chota Shingri is influenced by Asian monsoon during summer and also by the westerlies in the winter and offers a complex accumulation/ablation regime. The aim of this study is assessment of mass balance related glaciological parameters of Chota Shingri using ASTER data and its comparison with the published results of in situ measurements carried out using stakes and snow pack observations. Three atmospherically corrected surface reflectance products of ASTER of end of ablation season period (2002, 2003 and 2004) were used in order to classify the glacier into zones of snow, firn and ice. An ASTER DEM product was used for topographic correction of the images. Results of two different methods of topographic correction have been compared. A combination of thermal mask and NDSI mask has been examined to delineate the glacier. The ASTER thermal band was found to be effective means to separate glacier and surroundings and also removing clouds. The hypsography of the glacier was calculated by incorporating the elevation information of DEM. Glacier borders were delineated and the glacier surface was classified for assessment of snowline and AAR (accumulation area ratio). Models have been developed by relating AAR and annual mass balance and ELA and mass balance. The model results were compared to in situ net balance measurements of years 2002-2003 and 2003-2004. An attempt has also been made to relate the mass balance with glacial hypsography. A good fit between the mass balance measurements and accessed snow line and AAR was found. The results show that careful preprocessing would increase the value of the data. The results support the high potential of ASTER images for operational monitoring of alpine glaciers.

Keywords: mass balance, ela, aar

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JMS027 **Oral Presentation** **1506**

Changes of the equilibrium line altitude since the little ice age in the Nepalese Himalayas

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Changes of the equilibrium line altitude (ELA) since the Little Ice Age (LIA) in eastern Nepal have been studied using glacier inventory data. The toe-to-headwall altitude ratios (THARs) for individual glaciers were calculated for 1992, and then these ratios were used to estimate the ELA in 1959 and at the LIA. THAR for debris-free glacier is found to be smaller than for debris-covered glaciers. The ELAs for debris-covered glaciers are higher than those for debris-free glaciers in eastern Nepal. There is considerable variation in the reconstructed change in ELA (ELA) between glaciers within specific regions and between regions. This is not related to climate gradients but results from differences in glacier aspect: southeast and south-facing glaciers show larger ELAs in eastern Nepal than north- or west-facing glaciers. The average rate of ELA rise for debris-free glaciers in eastern Nepal between 1959 and 1992 (0.76 m a-1) was higher than the ELA rise between the LIA (AD 1815) and 1959 (0.38 m a-1). The limited number of climate records from Nepal, and analyses using a simple ELA-climate model, suggest that higher rate of the ELA between 1959 and 1992 is a result of the increased warming that occurred after the 1970s at higher altitudes of Nepal.

Keywords: glacier, ela, little ice age

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JMS027 **Oral Presentation** **1507**

RS and GIS Application for Glacier Changes in the Past Decades in the Qilian Shan, Northwest China

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Glacier has been recognized as the best terrestrial indicator of climate change by Intergovernmental Panel on Climate Change (IPCC), Glacier Monitoring is justified by the significance of glaciers foe glacial hazards、water resources、climate change and sea-level rise. The study area is located in northwest China along the northeast edge of Qinghai-Tibet Plateau , from 96- 102E and 3940′-3720′N, This area is arid/semi-arid region, the glacier melt water plays an important role in the water supply for irrigation、industrial and common life, especially in drought years. Results are derived from Enhanced Thematic Mapper Plus (ETM+)、topographical maps and aerial photographs using Geographical Information System (GIS) and remote sensing techniques. A trend analysis of glacier area changes between 1956 and 2000 is carried out for 2027 glaciers in Qilian Mountains in northwest China. The analysis shows that the total glacier area decreased from 1619.64 km2 to 1489.72 km2 (an 8% decrease). Glaciers with areas less than 1km2 contribute 54% (69.51km2) to total area loss (129.52 km2) while they covered 44% of the area in 1956. We estimate the volume of glacier by its area and find a 148 km3 volume loss from1956 (1306km3) to 2000 (1158 km3). It is apparent that the glaciers shrink is influenced by the temperature rise over the past decades.

Keywords: qilian shan, remote sensing, glacier changes

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JMS027 **Oral Presentation** **1508**

Glacier changes in the past three decades in the Yangtze River source region, Central-northeast Part of Qinghai-Xizang (Tibet) Plateau

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Many researches have shown that most glaciers of the world experienced a general reduction in area due to climate warming in the last decades. In this study, Glaciers in the Yangtze River source region in the central-northeast part of Qinghai-Xizang (Tibet) Plateau mainly distribute in the north-oriented slope of Mt. Tanggula, south-oriented slope of Mt. Kunlun and Mt. Sedir. Changes of glaciers in the Yangtze River source region were investigated using the 1:100000 topographic maps based on aerial photographs taken in 1968/1970, and the Landsat ETM+ imageries in (1999/2002). Glacier outlines of topographic maps were digitized as GIS-based vector files. The band ratio method of the Landsat ETM+ images was used to classify glaciers in the Yangtze River source region. For 32 glaciers, the automatically TM-derived areas turned out to be 2.3% smaller (on average) than on the manually delineated ones. It is found that glaciers in the region showed the opposite pattern in changes, with most shrinking but some expanding during the last three decades. However, glacier shrinkage dominated, e.g., 70% of the glaciers in shrinkage with a total area reduction of 72.1 km2 from 1968/1970 to 1999/2002 in the source region. The reduction rate of glaciers area is the largest in the Mt. Sedir and smallest in the north slope of Mt. Tanggula among the interested region. Generally, the larger of glacier area, the smaller of glacier change rate. According to the statistic analysis, there exists a decreasing logarithm relationship (R2=0.7337) between the glacier area and the reduction rate in the study area. Glacier ice wastage may be the consequence of the regional warming as indicated by records from meteorological stations of Zhiduo, Tuotuohe and Wudaoliang in this area.

Keywords: yangtz river source region, glacier changes, remote sensing

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JMS027 **Oral Presentation** **1509**

Modeling glacier runoff and its trend in the Yangtze River source region, China

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Glaciers are one of the important components of water resources in the Yangtze River source region, which have a significant contribution to the formation and change in the stream flow. Studies indicate that glaciers in the region have generally experienced retreating and thinning since 1960s due to climate warming. Under such changes in climate and glaciers, additional meltwater was released from glaciers thus modifying current streamflow of the Yangtze River source region. However, little is known about the variation of meltwater runoff in the region, where very few such data and studies exist. In this study, the variation of glacial runoff in the source region is simulated for the period 1961-2004 by applying a degree-day model. Results indicate that glacial runoff gradually increased over the period 1961-2004, which accounts for 10.6% of the total river runoff of the source region. It is found that glacial runoff during 1991 and 2004 plays a significant role in the water resource due to the dramatic decrease in stream flow during the observational period, while the contribution of glacier runoff to the total one in the source region is up to 17%. In addition, the changes of glacial runoff in the Dongkemadi catchment, a monitored representative glacierized catchment in the region, is analyzed based on a HADCM2 climate scenario. The increase in glacial runoff, by 31%, 49% and 107% respectively in 2020s, 2050s and 2080s, will be very pronounced due to the strong melting of glaciers in the catchment, meaning that glacial runoff will exert a distinct influence on the changes of river runoff in the present century in the Yangtze River source region.

Keywords: glacier runoff modeling, degree day model, climate scenario

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JMS027 **Oral Presentation** **1510**

Space monitoring of surging glaciers of the Pamirs

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It is known that surging glaciers are very dangerous to the population of mountain and foothill territories (e.g. Allalin Glacier, the Alpes, 1965; Kolka Glacier, Caucasus, 2002, etc.). In spite of the fact that the history of studying of mechanisms and the causes of glacier surges lasts already almost half a century, the problem remains actual. We consider, that the space monitoring of dynamically unstable glaciers of the Pamirs is one of the most productive methods of tracking of such glaciers behaviour. The Pamirs is the high-mountainous country where the dynamic instability of glaciers plays the great role in fluctuation of glaciation. Scientists of the Institute of Geography, Russian Academy of Science study Pamirs surging glaciers from the beginning of 1960th by ground methods and by means of repeated aerophotosurveys, and from the beginning of 1970th on the base of remote sensing. The space images used received from soviet satellites " Resource-F " (1972-1991) and from US satellites "Landsat-7 " and "Terra" (1999-2006). Owing to repeated remote sensing the Inventory of surging glaciers has been compiled for whole the Pamirs (1998). On the beginning of 1990th more than 250 glaciers with attributes of dynamic unstability has been revealed, surges of more than 50 glaciers were observed. On the base of photogrammetric measurements of a number of consecutive space images the changes of morphology and ice movement of the surging glaciers Gando-Dorofeev, Bivachny-MGU, Oktyabrsky (2002), RGO (2003), Sugran, etc. have been investigated in detail. Activization of glaciers in a stage of recovery occured rather slowly, being accompanied by the microsurges connected with overcoming by a moving ice of such obstacles, as riegels, turns and narrowings of a valley. The role of mutual damming of the main trunk and glaciers tributaries in general evolution of glacial systems has been especially investigated, e.g. the dynamic regime of Sugran Glacier for 1972 2006. During this period two surges took place: in 1977-1980 (internal) and in 2002-2005 (with advance of the terminus by 5 km). On the base of this study we develop some ideas on ground-air-space monitoring of the surging glaciers on the mechanism and causes of their motions, on the possibility of time and scale forecast of glacial catastrophes. We suppose that the space monitoring should be done before air and ground study. And in this case international cooperation is extremely important.

Keywords: glaciers, surging, space monitoring

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JMS027 **Oral Presentation** **1511**

Regional negative glacier mass balances since 2000 in the Himachal Pradesh of India (Western Himalaya)

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Although they correspond to an important fraction of the total area of mountain glaciers (33000 km2 out of 546000 km2), Himalayan glaciers and their mass balance are poorly sampled. For example, between 1977 and 1999, the average area surveyed each year on the field was 6.8 km2 only. No direct mass balance measurement is available after 1999 except on the new benchmark Chhota Shigri glacier, monitored since September 2002. We provide here remote sensing observations of negative mass balances for a 1000 km2 glaciarized area in the Spiti/Lahaul region (32.2N, 77.6E, Himachal Pradesh, Western Himalaya, India). Our measurements are obtained by adjusting and comparing a 2004 SPOT5 digital elevation model (DEM) to the 2000 SRTM (Shuttle Radar Topographic Mission) topography. On most glaciers, a clear thinning is measured at low elevations, even on debris-covered tongues. Between 1999 and 2004, we obtain an overall specific mass balance of -0.7 to -0.85 m/a (water equivalent) depending on the density we use for the lost (or gained) material in the accumulation zone. This rate of ice loss is twice higher than the long-term (1977 to 1999) mass balance record for Himalaya indicating an increase in the pace of glacier wastage. To assess whether these ice losses are size-dependant, all glaciers were classified into three samples according to their areal extent. All three samples show ice loss, the loss being higher for glaciers larger than 30 km2. In the case of the benchmark Chhota Shigri glacier, a good agreement is found between our satellite observations and the mass balances measured on the field during hydrological years 2002-2003 and 2003-2004. Future studies using a similar methodology could determine whether similar ice losses have occurred in other parts of the Himalaya and may allow evaluation of the contribution of this mountain range to ongoing sea level rise.

Keywords: west himalaya, glacier thinning, glims

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JMS027 **Oral Presentation** **1512**

Effect of precipitation seasonality on glacier mass balance

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In the recent studies on the glacier shrinkage and their effect on sea-level rise, sensitivity of glacier against warming (climatic sensitivity) are considered to be associated with annual amount of precipitation. On the other hand, it has been pointed out that glaciers under the Asian summer monsoon were vulnerable against warming rather than those under the Euro-American winter accumulation climate. Under the summer-accumulation climate, warming will change precipitation phase from snow to rain. This alternation will induce not only reduce of accumulation but also lowering of surface albedo, which will cause drastic melt. Since many climatic variables will affect glacier mass balance and its climatic sensitivity, however, it has been questionable whether only precipitation seasonality dominated them. The author examined a comprehensive model calculation changing annual amount, degree of seasonal concentration and seasonality of precipitation under different latitudes using a simple periodic pattern of meteorological variables. The result clearly shows the assertion that climatic sensitivity of glacier mass balance strongly depends on seasonality and concentration of precipitation rather than the annual amount. This study shows that Asian glaciers located under the summer monsoon climate are potentially more vulnerable against the warming than previously thought.

Keywords: climatic sensitivity, asian monsoon, precipitation seasonality

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JMS027 **Oral Presentation** **1513**

Glacier evolution in the Sagarmantha National Park of Nepal 1956-2006

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After 50 years, a series of repeat photographs were made in the Sagarmantha National Park of Nepal in October 2006, most of them with glaciers as the subject (Imcha-, Khumbu-, Ngozamba-, Bothe Koshi-Glacier). The former photographs were taken mainly in 1956 by glaciologist Fritz Mller who was as a scientific member of the Swiss Everest Expedition. After comparing about a dozen pairs of photographs, the qualitative results show that the main valley glaciers did not change much in length nor in shape at the front, due to a substantial coverage of debris (Khumbu/Ngozamba/Bothe Koshi Glacier). Only the formation of larger lakes at the glacier snout causes a noticeable retreat (Imcha Glacier). Considerable thinning of glaciers was found at higher elevations of the valley glaciers. This could be recognized also by the strong destabilisation of the inner sides of the moraines due to the loss of ice pressure to the side. Several small glaciers without mass gain from high elevations have disappeared. Steep small glaciers with an accumulation area at high elevations have not changed much in shape. This is probably due to higher snowfall amounts during the monsoon seasons after 1994 at high altitude as reported for the Gokyo area and confirmed by Kathmandu precipitation series. This mass gain partly compensates the general ice loss due to climate warming and a general increase in the equilibrium line altitude, which affects mainly the valley glaciers and the glaciers with a low accumulation area.

Keywords: glacierevolution, sagarmantha, 1956 2006

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JMS027 **Oral Presentation** **1514**

Modelling the surface energy balance of debris-covered glaciers: calculation of sensible heat exchange and meltwater evaporation

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Many glacier ablation zones in the Asian high mountains are mantled by thick debris which insulates the underlying ice from atmospheric heat and insolation. A detailed understanding of energy exchange between debris covers and the atmosphere, and of heat transfer within debris covers, is clearly important for calculation of the response of these glaciers to climate change. While sophisticated energy balance models have been developed for bare glacier surfaces, comparable models for debris-covered ice are relatively simplistic. Furthermore, large diurnal variations in debris surface temperature and unknown moisture levels within debris covers present challenges for physically-based modelling of buried ice melt rates using meteorological data. Since 2005, a comprehensive energy balance programme has been carried out at debris-covered Miage Glacier, Mont Blanc Massif, using automatic weather stations and sub-surface temperature and humidity microsensors. Several tributary glaciers draining the west side of Mont Blanc (4810 m a.s.l.) feed a deeply incised and gently sloping glacier tongue which is continuously mantled by rock debris for >5 km upglacier from the snout (1770 m a.s.l.), making Miage Glacier a good analogue for debris-covered glaciers of the Asian high mountains. The measurements reveal strong daytime atmospheric surface layer instability, which enhances heat loss from the debris to the atmosphere, and meltwater evaporation from within debris layers; both of which significantly reduce the energy available for melting glacier ice buried by debris. Methods for incorporating the former effect in energy balance models are developed and shown to be successful through closure of the surface energy balance. The latter observation raises questions over estimates of freshwater supply to lowland rivers, and the global sea-level rise contribution from debris-covered Asian high mountain glaciers.

Keywords: debris covered glacier, energy balance model, meltwater

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JMS027 **Oral Presentation** **1515**

Significant effect of biogenic material (cryoconite) on surface albedo of Asian glaciers: geographical comparison of the amounts of cryoconite and surface albedo of glaciers

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Cryoconite is biogenic material on the glacial surface and common on many glaciers in the world. It is derived from special organisms living on glaciers, such as snow algae, insects, and bacteria. Cryoconite on the glacial surface could reduce surface albedo of snow and ice, then accelerate melting of the glaciers. Thus, it is important to study characteristics of the cryoconite on glaciers. The cryoconites collected from many glaciers in the world including Arctic, Alaska, Patagonia, Himalayas, and Tienshan were chemically and biologically analyzed. Results showed that the amounts of cryoconite on the Asian glaciers were significantly larger than those on the glaciers in the other regions and that surface albedo also significantly lower on the Asian glaciers. These facts suggest that the mass balance of the Asian glaciers could largely affected by the biogenic material. Analysis of snow algae in the cryoconite revealed that the Asian cryoconite contained a large amount of cyanobacteria, while the cryoconite of the other regions contained mainly green algae. Results suggest that propagation of the cyanobacteria may be responsible for the larger amounts of cryoconite on the Asian glaciers.

Keywords: cryoconite, glacier, albedo

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JMS027 **Oral Presentation** **1516**

Glacier shrinkages and attendant expansions of glacial lakes in the Bhutan Himalayas

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Japan-Bhutan joint field observations were carried out since 1998 till 2004 in the Bhutan Himalayas in order to investigate shrinkage of glaciers and expansion of glacial lakes and to improve risk assessment of the glacial lake outburst floods. In addition to the field observation studies, satellite remote sensing was applied to evaluate expansion rates of moraine-dammed glacial lakes in the Bhutan Himalayas, too. The present paper summarizes and discusses corresponding results in the field observation and the remote sensing studies. The first field observation in 1998 was mainly executed for monitoring 30 glacial lakes and reconnoitering glaciers in northern and northwestern parts of Bhutan. The following observation in 1999 was mainly for exploring variations of debris-free glaciers as well as surrounding climate in the northern part, Lunana region. Then since 2002 till 2004, intensive observations have been annually performed in the Lunana region. One of the main targets is variations of neighboring two debris-covered glaciers, Lugge and Thorthormi Glaciers. The former terminates into a huge moraine-dammed glacial lake, Lugge Tsho, but the latter has no huge moraine-dammed glacial lake at present except several supraglacial ponds. Repeated surveys on their ablation areas revealed contrastive shrinkages; surface lowering rate on the former was evaluated as quite rapid to be approximately 5 m a-1, but that of the latter was roughly up to its half. On the other hand, mean ablation rates on both the ablation areas have been estimated to be equivalent each other, through heat budget with meteorological data and surface temperature data from satellite. These imply that a huge moraine-dammed lake can promote surface lowering on the corresponding glacier through accelerating flow of the glacier terminal part and weakening compressive flow (emergence velocity) on the glaciers ablation area, which are consistent with the results of flow measurements on the Lugge Glacier. From analyzing satellite images captured by CORONA satellite in 1960s and SPOT satellite in 1993, expansion rates of moraine-dammed glacial lakes in Bhutan were evaluated. As a result, they could be classified into two categories; rapid area expansion of larger rate than 0.01 km2 a-1, and almost stable expansion of smaller rate by one order than the value. The formerly categorized lakes are expanding through active calving. Initiation and activities of the calving should be strongly affected by buoyancy of lake water at glacier terminal part, and the buoyancy effect becomes relatively larger as glacier is thinning. Combined with the preceding implication, a positive feedback mechanism could be recognized between shrinkage of a glacier and its attendant expansion of glacial lake after active calving has once started.

Keywords: bhutan himalayas, glacier surface lowering, moraine dammed glacial lake

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JMS027 **Oral Presentation** **1517**

Spatial distribution of surface energy balance at debris-covered Baltoro glacier, Karakoram, Pakistan

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A distributed surface energy balance study is performed at Baltoro Glacier, one of largest debris-covered glaciers in the Karakoram Range, . Meteorological data from AWSs located on the glacier surface (Base Camp, 5033 m a.s.l) and outside the glacier boundary, on the lateral moraine (Urdukas 4022 m a.s.l.) are used to calculate spatial distribution of energy available for melting over the ablation zone. Physical and thermal characteristics of the debris layer are taken into consideration as well. The performed study aims also to analyse the influence of debris thicknesses on melt distribution. Over the period 2004-2006, the spatial distribution of melt energy at debris-ice contact across the ablation area of Baltoro Glacier is calculated from Urdukas AWS meteorological data. Comparisons with a degree-day model and field measurements reveal good performance of the model in predicting melt over wide areas. The model underestimates melt rates over highly crevassed areas and water ponds, where there is a high variability of the debris thickness distribution. In addition we examine the spatial distribution of the energy-balance components over the ablation area of Baltoro Glacier. The results from this analysis allow us to quantify, for the analysed period, the melt water production of Baltoro glacier in dependence of the prevailing meteorological conditions. Due to its debris mantle and accumulation area extension, Baltoro Glacier seems to be less sensitive to climate change than debris-free glaciers in the vicinity.

Keywords: energy balance, debris covered glacier, baltoro glacier

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JMS027 **Oral Presentation** **1518**

A 3D Mixed Laser-Scanner and Photogrammetry Survey Approach for High-Altitude Glacier Monitoring

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The paper presents a novel approach for 3D-surveying and modelling of high-altitude glaciers, based on different techniques and scales for data collection and a unique software platform to manage large data sets (from laser scanning, photogrammetry, topographic maps and GPS), finally leading to a unified model extraction, a promising result for an optimised integration. Photo-grammetry, kite-based aerial photography and terrestrial laser scanning have been tested on the Lobuche, Changri Nup and Khumbu Glaciers located in the Mount Everest Area (Nepal Himalaya). Multi-temporal stereo-imagery like the one from Terra-ASTER would represent an ideal tool to develop an automated way of monitoring both clean and debris-covered glaciers in planimetric extension and volume. However, when using ASTER data alone, due to their medium resolution this leads into inaccuracies and misinterpretation. A significant improvement could be made through the integration of stereo-imagery acquired by digital cameras attached to kites, a low-cost and low-altitude technique used to generate accurate digital elevation models and high-resolution orthophotos of confined parts of the glacier surface. The highest accuracy can be obtained by terrestrial laser-scanning. Colour information collected by digital camera has been draped over a geometry model gained by a laser-scanner, organized in point clouds, and georeferenced by means of accurate GPS positioning. This resulted in a precise three-dimensional photorealistic model of the glacier, limited only by possible occlusions due to the ground-based point of view and sometimes restricted by the high geomorphological complexity. The combination of geometry model and colour texture from terrestrial surveying with detailed low-altitude imaging for high-resolution data represents an ideal possibility for calibration within an automated glacier monitoring process based on satellite imagery.

Keywords: modelling, laser, photogrammetry

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JMS027 **Oral Presentation** **1519**

The sensitivity to climate change of Eurasian glaciers assessed with a gridded glacier-climate model

Dr. Roger Braithwaite

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The World Glacier Inventory is nearly complete for Eurasia allowing us to study geographical variations in glacierareas and altitudes from the high Himalaya to the Arctic islands. We aggregate the original data for tens of thousands of glaciers for half degree grid squares and we estimate climateconditions at the average equilibrium line altitude (ELA)for each grid square from the UEA/CRU gridded climatology. We then apply a degree-day model to calculate annual accumulation at the ELA (equal to annual ablation) and assess the sensitivity of mass balance to climate variations by varying temperature and precipitation in the degree-day model. We analyse the resulting geographical fields of annual accumulation, and temperature and precipitation sensitivity of mass balance, to infer the large-scale controls on the geographical distribution of glaciers in Eurasia. We find the classical concepts of maritime and continental climate robust for purpose. We discuss the implications of ourwork on regional (hydrology) and global scales (sea level).

Keywords: glaciers, climate, models

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JMS027 **Oral Presentation** **1520**

Surface variations of Sagarmatha National Park (Nepal) glaciers in the second half of the 20th century by historical maps

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Aim of this contribution is the evaluation of surface variations of Sagarmatha National Park glaciers during the second half of the 20th century, by GIS-based processing of historical maps. To evaluate glacier variations different historical maps were used: 1) a map which could be considered representative of the fifties, at the scale 1:50.000, by Nellas, Verlag. Munich, F.R.G. (1978) from photogrammetry of 1921 and of the 1935-39 period, with the terrestrial survey done by E. Schneider in the 1955-1963 period (Schneider, 1967); 2) a map which could be considered representative of the beginning of nineties, at the scale 1:50.000, by the Survey Department of His Majestys Government of Nepal in cooperation with the Government of Finland from aerial photogrammetry of 1992, with the terrestrial survey done in 1996. By using GIS software the maps were managed after digitalisation; Digital Elevation Models were produced and their comparison allowed to quantify surface variations and to relate the surface variations with some morphologic parameters and their variations (size, elevation, slope, aspect). The main results about surface variations obtained from maps are the following: a) a total reduction in glacier surface (4.8 %, from 404 km2 to 385 km2) that can be defined of slight size; considering the magnitude of the error produced by the cartographic interpretation the global variation could be defined not significant. This result disagrees with data coming from the Alps, but it is explainable considering whether the typology of the Himalayan glaciers (mainly debris covered glaciers with a longer response time), or the time period considered (it includes also the cold phase before the eighties). However, a strong unhomogeneity among glaciers variations is noticed. b) the largest losses occurred for little size glaciers and for glaciers located at a lower elevation while, on the contrary, the greatest ablation resistance is observed for the largest glacier masses. c) the increased glaciers have mainly a South aspect, while the decreased ones are mainly South-West exposed. This different distribution could be explained considering mainly the local topographic and morphologic characteristics and the South-North axis of monsoon precipitations (the Khumbu area represents a good exemple). d) the main surface differences are noticed in correspondence of the glacier accumulation zones, while both for positive and negative surface variations the minimum altitude remained constant and thus the glaciers snouts have not shown, on average, either a retreat or an advance. In the future this comparison could be extended to the current period through the integration with satellite images because a updated cartography is not still available.

Keywords: sagarmatha national park, glaciers, surface variations

JMS027 **Poster presentation** **1521**

Prospective change of the central asian rivers runoff and glaciers state under different climate scenarios

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KONOVALOV VLADIMIR1, Agaltseva Natalya2 1Institute of Geography RAS, Moscow, Russia, 2 Research Hydrometeorological Institute, Uzbekistan Several large and small Central Asian watersheds with noticeable snow and ice-melt contribution to the river runoff formation were selected for assessing there the impact of prospective climate change. Applied complex of runoff simulation includes the following components: model of snow cover formation in the mountains, model of glaciers runoff, and model transformation of the rain, ice and snowmelt volumes into rivers stream flow. Main climatic and topography peculiarities of rivers runoff formation area located in the alpine regions of the Tien-Shan and Pamir Alai were taken into consideration in the computation procedure. It is turned out to be that the water resources of the region may increase by 3-5 % if the forecasts on 2000-2030 for air temperature and precipitation and different scenarios of greenhouse gas emissions related to Central Asia will be realized. Tendency of water resources conservation at the present state or some their decrease is revealed at computations without taking into account of precipitation changes. Anticipated anthropogenic climate changes estimated also by means of the balanced models of general circulation of atmosphere. Computations of possible runoff feedback on climate change showed that in the case of CCCM (Canada) scenario realization the runoff will be decreased up to 40-50 % in small river basins and on 20-30 % in large ones. The unfavourable situation may arise when climate change will follow to the UKMO (England) scenario. In this case, decrease of surface waters resources up to 10-20 % can be expected. More favourable situation is possible in the case of GFDL and GISS (USA) scenarios realization. Calculations by model demonstrated that in the far future, the glacial runoff will be depended on the reduction rates of mountain glaciation. It is known that glaciers in the Aral Sea basin during 1957-1980 have lost 155.5 km3 of ice volume, which is equalled almost 20% of the ice reserves in 1957. Another 14% of the 1957th reserves were lost at the 2000. Glaciers there will lose additionally at least 10-15% of their initial volume by 2020. 1. JMS027 2. Glacier Fluctuations in the Asian High Mountains 3. river runoff change, regional climate, glaciers evolution 4 vladgeo, instaar,Vladimir Konovalov, Department of Glaciology, Institute of Geography, Russian Academy of Sciences, 29, Staromonetny per., Moscow, Russia Tel. 7 495 959 0035, fax 7 495 959 0033, e-mail: vladgeo_exp@mtu-net.ru 5. P 6. PC 7. NO 8. Konovalov Vladimir: YES, Agaltseva Natalya: NO 9. NONE

Keywords: river runoff change, glaciers evolution, regional climate

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JMS027 **Poster presentation** **1522**

Monitoring of glacial landforms in Western Tien Shan using RS GIS

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Glaciers are of great significance considering their active role, first of all, in water resources. Monitoring of glaciers can provide the basis to understanding interrelations between glaciers, climate and water resources. Glaciers in Middle Asia are mainly developed in the Tien Shan's high mountains at the mid-low latitudes. At present time in the Middle Asian High Mountains - 14752 glaciers, the total area 15761km2. In our study , satellite images, topographical maps were integrated into a glacier inventory system to extract glaciers changes in the Western Tien Shan, especially in Tekeshsai, Barkrak (middle and left), Lakely glaciers with a total area of 38.8km2 were digitized and analyzed. We applied the ASTER images for visual interpretation and classification of glaciers. Glacier tongues with debris-covers were manually delineated from satellite images with the aid of DEM. Results indicated that glaciers Tekeshsai, Barkrak, Lakely have retreated from 1985 to 2006 with a total area reduction of 7.9km2, 16.8 % of the area during the last 20 years. However, there are different types of glaciers, classified as maritime, based on the precipitation amount and air temperature combination. At the same time, most of glaciers in Western Tien Shan have lost substantial volumes of ice. Mountain permafrost and associated periglacial landforms contain large quantities of belowground ice. The moraines, rock glaciers and other coarse blocky materials have especially high ice content – more than 50% by volume. Coarse blocky debris of various origins is widespread in the Tien Shan and occupies large areas of high-mountain territory. Under continuing warming of permafrost and glacier regression in Tien Shan, the melt waters from thawing permafrost could become an increasingly important source of fresh water. Further analysis revealed that regional warming during the past decades could be the consequences of this large scale ice mass wastage.

Keywords: tienshan, glacials, monitoring

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JMS027 **Poster presentation** **1523**

Spatially distributed surface energy balance and ablation modelling on the on the Koxkar Baqi Glacier,Tienshan Mountains,China

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Prodominatelly caused by intense ablation Alpine glaciers has greatly retreated in the last decades in Tienshan Mountains,China.To investigate the characteristics of ablation at Koxkar Baqi Glacier,a alpine glacier under continental climate in Tienshan Mountains,China, A comprehensive field programme was conduceted from 2003 september including the operation of two automatic weather stations(AWSs) and ablation measurements at different altitudes.These data were used to drive a spatially distributed energy balance model to investigate melt during the ablation peroid of 2003-2005. Averaged over the study area and over the calculated period net radiation is the dominant energy source, followed by sensible heat, while latent heat is an energy sink indicative of sublimation. Increasing air temperature by 1 and 2 K didnt significantly enhanced spatially averaged ablation. The direct reason was the deep debris layer on the glacier ablation zone. the magnitude and partitioning of energy balance terms and consequently ablation, varying across the whole glacier seasonally and spatially,demonstrate that such monitoring programmes are required to truly represent and provide a sound basis for researching into glacier energy and mass-balances in both space and time.

Keywords: surface energy balance, distributed modelling, koxkar baqi glacier

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JMS027 **Poster presentation** **1524**

The evolution of the high altitude geomorphologic processes and landforms by the GIS aided monitoring and mapping: the study case of Rongbuk Glacier on the Mount Everest northern slope (Tibet, China)

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Scientific and technical research ITALIAN MOUNTAIN INSTITUTE IAMAS

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The shrinkage and degradation of the cryosphere are surely the most important evidences of the high altitude mountain areas of the world fast changes. In such an environmental framework, the retreat of the Rongbuk Glacier and the general reduction of the glaciers in the Northern (Tibetan) slope of Mount Everest are widely inducing fast gravitational phenomena involving both ice/snow and rock/debris. At the same time the reduction in volume and the retreat of the glacier tongues are promoting new conditions for the superficial and epiglacial runoff action and for the water concentration in the terminus area. This so quickly changing environment seems to show a direct transition from glacial to paraglacial processes in a relatively reduced spatial and temporal scale. The monitoring and mapping, with GIS technology, of both glacial/periglacial and paraglacial processes and landforms, appear very important in studying the landscape evolution, also from the point of view of increasing risks for tourism and mountaineers frequentation. A particular attention has been concentrated on surveying and mapping already developed and, above all, on still active geomorphologic evidences and conditions of GLOF (Glacial Outburst Floods). In fact in the terminus area the geomorphologic evidences of a recent GLOF has been mapped, with the detailed survey of the failure area, of the erosion channels and of the debris cone. Furthermore the evidence of the evolution of a new one has been surveyed on top of the tongue snout, also promoting risks condition on the mountaineering base camp below. Moreover several evidences of rapid-evolution geomorphologic processes of the high altitude, such as ice falls, avalanches and rock/debris avalanches, are surveyed and described From the methodological point of view the extraction and the availability of DTMs and digital data implemented and mathematically obtained (respectively from traditional or numerical supports) or survey data -also in real time- allow to reconstruct the past morphologic evolution and to design scenarios of glacier retreats.

Keywords: glacial geomorphology, cryosphere shrinking, glacial risks

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JMS027 **Poster presentation** **1525**

Glacier runoff modeling in the Tuotuo River Basin of the Yangtze River source region, China

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The Tuotuo River Basin is one of the heavily glacierized watersheds in the Yangtze River source region, China. In the basin there are 92 glaciers with the total area of 370.29 km2. Glaciers are one of the important components of water resources in the Tuotuo River Basin of Yangtze River source region, which have a significant contribution to the formation and change in the stream flow. Based on Landsat ETM+ and topographical maps, we find that glaciers in the basin have generally experienced retreating and thinning since 1960s due to climate warming. Comparing the amount of glacier advance to the amount of glacier retreat, there was a net decrease of 3.5% in the total area during the 1960s. Under such changes in climate and glaciers, additional meltwater was released from glaciers thus modifying current streamflow of the Tuotuo River Basin. However, little is known about the variation of meltwater runoff in the basin, where very few such data and studies exist. In this study, the variation of glacier runoff in the basin is simulated for the period 1961-2004 by applying a degree-day model. Results indicate that glacier runoff gradually increased over the period 1961-2004, which accounts for 53% of the total river runoff of the basin. It is found that glacier runoff since 1990s plays a significant role in the water resource due to the dramatic decrease in stream flow during the observational period. The contribution of glacier runoff to the total runoff in the Tuotuo River Basin is up to 75% for the period 1991-2004. It can be seen that that glacier runoff will exert a distinct influence on the changes of river runoff in the Tuotuo River Basin of Yangtze River source region under changes in climate and glaciers.

Keywords: glacier change, glacier runoff, modeling

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JMS027 **Poster presentation** **1526**

Sensitivity of glaciers in the Himalayas and the Tibetan Plateau to global warming

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We show the relation between annual precipitation and sensitivity of glaciers in the Qilian Mountains, the Tanggula Mountains, and the Nepal and Bhutan Himalayas to 1 deg C warming by means of mass balance model. The estimated glacier sensitivity shows that glaciers in the Himalayas and the Tibetan Plateau is more sensitive than those in other areas, and the difference between the sensitivity to warming in these regions and that in other areas becomes large with the increase in annual precipitation. Summer snowfall provides the most of the mass input of glacier in the Himalayas and Tibetan Plateau, and high surface albedo kept by summer snowfall restrains ablation of glacier in these regions. Warming in the Himalayas and Tibetan Plateau can cause significant albedo reduction. Therefore, glaciers in the Himalayas and the Tibetan Plateau are more sensitive than those in the area where glacier accumulation depends mainly on snowfall in winter. Most previous studies of glacier sensitivity, however, did not touch on this albedo reduction in summer, and they would underestimate the glacier sensitivity in the Himalayas and the Tibetan Plateau.

Keywords: glacier sensitivity, global warming, himalayas and tibetan plateau

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JMS027 **Poster presentation** **1527**

A new benchmark glacier in the Western Himalaya: Chhota Shigri Glacier (Himachal Pradesh, India)

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Given the crucial interest of Himalayan glaciers in terms of future water supply, sea level rise and regional climate change, and given the lack of data, starting a long-term monitoring programme on an Himalayan glacier was an urgent need. Consequently, the Great Ice IRD Research team (France) together with the Jawaharlal Nehru University (India) started in 2002 a long-term monitoring program on Chhota Shigri glacier (32.2N, 77.5E; 15.7 km2, 6263 to 4050 m a.s.l., 9 km long) located in Lahaul and Spiti valley, Himachal Pradesh, India in the framework of UNESCO FRIEND Programme and under the initiative of Commission on Cryospheric Sciences. This glacier lies in the monsoon-arid transition zone (western Himalaya) which is alternatively influenced by Asian monsoon in summer and the mid-latitude westerlies in winter. The results of 4 years of mass balance and 3 years of surface velocity field measurements between 2002 and 2006 are presented. Overall specific mass balances are mostly negative during the studied period and vary from a minimum value of -1.4 m water equivalent (w.e.) in 2002-2003 and 2005-2006 (Equilibrium line altitude (ELA) of 5180 m a.s.l.) to a maximum value of +0.1 m w.e. in 2004-2005 (ELA of 4855 m a.s.l.). The glacier moves faster in the upper part of the ablation zone with maximum flow velocities higher than 45m y-1 than in the lower part where velocities are around 25m yr-1. 2003-2004 velocities are slightly higher than velocities reported the following years.

Keywords: glacier mass balance, western himalaya, long term monitoring network

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JMS027 **Poster presentation** **1528**

Baltoro Glacier, glacier evolution during the last 100 years from historic data and remote sensing information

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Baltoro Glacier is one of the largest glaciers in the Karakoram, draining an area of roughly 800 km. Almost the entire tongue of Baltoro Glacier is debris covered, reaching from the tongue up to an elevation of roughly 5000 m. Especially in the arid regions of High Asia melt water from glaciers provide an important contribution for irrigation during the summer months. Thus, the temporal evolution of major glaciers over longer time spans could provide important insight into the future availability of melt water. For Baltoro Glacier a long history of observations is available reaching back to the first visits of foreigners to the glacier at the end of the 19th century. A detailed analysis of available historic photographs and more recent satellite imagery enables the reconstruction of the glacier extent and estimates about volume changes during almost one century. It turns out that Baltoro glacier is rather insensitive to medium term climate fluctuations. Despite considerable changes on smaller tributary glaciers, the main glacier shows no significant change in glacier length. Also the ice thickness changes are small compared to the glacier reaction in other mountain regions. However, during the last decades a considerable increase in debris cover could be observed up to 5000m.

Keywords: karakoram, baltoro glacier

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JMS027 **Poster presentation** **1529**

Accumulation conditions in a high elevated glacier basin in the eastern Karakoram

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Glacier reactions on climate are basically divided into two parts. The lower regions are affected by ablation conditions, mainly governed by the surface energy balance. In the higher parts, ablation plays only a minor role and the mass budget is primarily influenced by the amount of accumulation. The large valley glaciers in central and eastern Karakoram are characterised by extensive debris cover on their glacier tongues, where ablation depends on the debris cover characteristics. A quite large number of studies are concerned with the loss of mass on such glacier tongues, whereas only a small number of investigations exist about the mass input into the High Asian glacier systems. This is partly due to the difficult access to the accumulation basins, usually situated in rather high elevations. Also representative locations are not easily identified due to locally highly variable conditions. During 2006 accumulation studies have been performed in an accumulation basin of Urdok glacier, on the northern slope of the main divide of the eastern Karakoram. This glacier is influenced by both, the monsoon from the Indian Ocean and the stable high pressure system over the Tarim basin, depending on the respective dominance. Samples from snow pits in more than 5000m elevation provide for the first time information about the annual snow accumulation in this region. From isotope and dust measurements also the temporal variation could be identified, including the potential source areas. In combination with climate records of stations in the larger region, the accumulation conditions for high elevation glacier basins can be characterised.

Keywords: glaciers, central asia, accumulation

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JMS027 **Poster presentation** **1530**

Analysis of glacier recession in Northern Tien Shan in the last 50 years using GIS and remote sensing

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The glaciers of Zailiyskiy and Kungey Alatau in Northern Tien Shan are retreating in average like in many other parts in the world. These mountain ranges are characterized by an overall continental climate, but with sharp differences within. In order to quantify the aerial retreat first the recent glacier coverage was delineated in a semi-automated way using a TM4/TM5 ratio image of a Landsat ETM scene from the year 1999 and a merged ASTER/SRTM3-DEM. The extent of these glaciers was compared with those of the Soviet Glacier Inventory, which represents the situation in study area in approx. 1955, with glacier areas of the late 1970s digitized from topographic maps and a Landsat MSS scene and with those of 1990 based on the Kazakh glacier inventory and a Landsat TM scene. However, a comparison of the data from the soviet glacier inventory with a topographic map scale 1:10000 of the year 1958 showed differences of more than 5%. Also the glacier outlines of the topographic maps are with problems. Therefore the presented percentages might be a little overestimated, but the overall tendency is coherent. Regionalization of temperature and precipitation based on 16 gauging stations situated in different altitudes as well as solar radiation calculation were conducted in order to determine the climate situation at the glaciers. Due to precipitation characteristics the glaciers at the northern slopes are the most maritime under the continental glaciers. On the average, the decrease in ice extent was more than 32%, the estimated volume loss more than 37% between 1955 and 1999 in the investigated valleys of Zailiyskiy and Kungey Alatau. The retreat clearly became pronounced in the 1970s and has decreased slightly since about 1990. However, the glacier recession was not homogeneous, but depended strongly on the size, location and climate regime at the glaciers. A few glaciers even advanced during different periods. The overall area loss of the continental-type glaciers with very predominant summer accumulation, as for those situated in the deeply incised Chon-Kemin valley between Zailiyskiy and Kungey Alatau, was conspicuously less (< 20%), in parts, than the loss at the more maritime glaciers on the northern slope of Zailiyskiy Alatau (~35%). This is consistent with the small increase in summer temperatures. However, under dryer conditions with high solar radiation input, such as with glaciers in the Chon-Aksu valley in Kungey Alatau, the area retreat of the continental-type glaciers can be even more pronounced than that of the more maritime glaciers (~40%). Compared to other parts of the Tien Shan the glacier recession is highest at the investigated area.

Keywords: tien shan, glacier recession, glacier mapping

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JMS027 **Poster presentation** **1531**

Recent climate change in the Tien Shan mountains as documented by Gregoriev Ice Cap ice-core records, glacier retreat, and dendrochronology

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Five shallow ice cores have been recovered from the summit of the Gregoriev Ice Cap (41.98 N; 77.92 E; 4609 m a.s.l.) in the Tien Shan, Central Asia between 1990 and 2003. The 1990 ice core has been analyzed for stable isotopes, microparticle concentration, major ions (K+, Na+, Ca2+, Mg2+, SO42-, NO3-, Cl-) and total beta-activity. The 2001 and 2003 ice cores have been analyzed for stable isotopes and concentration of radionuclides (40K, 226Ra, 232Th, 235U, 238U, 137Cs, 90Sr). These ice cores have been dated on the base of set of reference horizons and annual microparticle concentrations. The detailed stratigraphic records for the top sections of the 1990 and 2001 cores indicate that 3.8 m of snow/firn accumulated in the 11 years. The mean annual net accumulation derived from this comparison is 0.35 m in ice equivalent (i.e.) (260 mm w.e.) for the period from 1990 to 2001. The net accumulation from 1963 to 1990 was 0.42 m i.e. (320 mm w.e.). Moreover decrease of firn pack depth from 9 to 6 meters has been observed at 4450 m site between 1962 and 2003. Over the same period infiltration ice concentration has been increased as a result of more intensive melt water percolation. Considerable enrichment in stable isotope composition for the top section of the 1990 and 2003 ice cores has been measured. Local meteoric water line is compared with global one. The relationship between d18O in ice cores and mean summer air temperature has been determined and compared with results from other glacier areas. Temperatures were measured in the boreholes on the top of the Gregoriev Ice Cap (4609 m) in 1990, 2001 and 003. Their comparison shows an approximate 1C warming at 10 m depth between 1990 and 2003. Likewise considerable warming has been measured in boreholes drilled at 4450 m in 1962 and 2003. The temperature rise is ~2.5C at 10m and 0.5C at 30 m depth. The comparison of airborne images from 1956 and 1988 and satellite image from 2001 show considerable retreat of glacier terminus since 1956. This rate of retreat is compared to that determined from LIA moraine positions.This regional warming marked by changes of ice content and stable isotopic composition of the ice cores along with increasing glacier temperatures is consistent with data from the Tien Shan meteorological station.60 samples of Picea Schrenkiana, collected in 2001 and 2002 on the Northern slope of Terskey Ala-Tau at the upper (2900 m) and lower (2000 m) tree limits to construct the new ring-width chronologies have been used. The ring width of Picea Schrenkiana at the lower tree limit strongly depends on May-June precipitation, and also correlates positively with the precipitation of the cold period (October-May). The climatic signal reflected by tree-rings at the upper tree-limit is more complex and it reflects both temperature and precipitation influence. Assuming that the lower tree line in the arid Tien Shan Mountains is limited by precipitation and the upper tree line by temperature we combined the lower tree-limit indices and the inverted upper tree line indices to enhance the signal that might be important for the glacier mass balance. ACKNOWLEDGMENTS This study has been supported by International Scientific and Technological Center, grant 2947.

Keywords: ice core, dendrochronology, climate

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JMS027 **Poster presentation** **1532**

The present quiescent phase of a surge-type glacier: Liligo glacier (Karakoram, Pakistan)

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Liligo (3542' N, 7613' E) is a 15 km long surge-type valley glacier flowing on the South side of Baltoro Glacier (Karakoram). Its tongue is partially debris covered and its terminus is located at 3822 m. Liligo Glacier terminus variations have been reconstructed since 1892 by means of various methods and sources (historic documents, cartography, photographs, satellite images and field surveys). The glacier has been characterised by two strong advancing phases (at the beginning and at the end of the 20th century), separated by at least half a century of retreat. The satellite images in particular show very clearly the second advancing phase of the two last twenty years of the XX century. Easily recognisable morphologies (heavily crevassed surface and terminus morphology) during the advancing and retreating and information obtained by the poor literature available give clear signals of a surge-type phenomenon. In summer 2004 a field campaign has been conducted in the Baltoro area and new measurements and data have been collected on Liligo Glacier. During the Italian expedition K2 1954-2004: 50 anni dopo, 3D Laser scanning and GPS measurements have been used and integrated on Liligo Glacier to describe the present phase and its terminus morphology. Field surveys allowed recognizing the evidences of a quiescent and retreating phase started after a surging period and describe some basic dynamic behaviour of the glacier itself. The displacement of natural benchmarks of the glacier surface was measured by comparing multi-temporal laser scanner surveys. A detailed map of glacier snout was obtained as well by contouring the 3D model of the glacier surface obtained from the laser scanner survey. GPS RTK qualitative data supported by the quantitative analysis obtained with 3D technology made it possible to understand that the last advancing (surge type) phase is now finished; no more crevasses are visible in the terminus area and the snout is not so steep as just few years ago. GPS assisted GPR investigations have been conducted as well, providing profiles of the glacial bed. Moreover the present retreating phase is evidenced by a growing ice contact lake at the confluence with Baltoro Glacier into the Braldo Valley. Such kind of ponds are typical of fast glacier retreating events where the presence of moraine ridges produces favourable settings for the collection of melting waters and the formation of ice contact lakes.

Keywords: surge type, karakoram, debris covered

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JMS027 **Poster presentation** **1533**

The 3D evolution of the front of the high altitude glacier Lobuche in Everest National Park

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Since 2003 the researchers of the University of Brescia have surveyed the fronts of the Changri Nup and Lobuche glaciers, inEverest National Park, using a mixed laser scanning and GPS approach. The front of the Lobuche, has been surveyed in 2003 and in 2006, obtaining for both sessions an high resolution 3D model, composed by the combination of two laser scans. Each model has been individually analysed. Later has been applied an inspection approach to measure and highlight the three dimensional variation of the front in the 2003-2006. Sections, plans, three dimensional measurable models, usable also for geomorphological analysis, have been produced and volumes of ice evaluated. The scans in the time have been georeferenced using reflecting targets positioned in cartography by geodetic, centimeter accuracy, GPS relative positioning approach.

Keywords: laserscanning, gps, 3dsurvey

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JMS028 **1534 - 1552**

Symposium
Consequences of Large Scale Circulation Variability on Snow and Ice Extent (UCCS Symposia hosted by IAMAS)

Convener : Dr. Steven Fassnacht

Atmospheric circulation patterns significantly influence the seasonal, inter-annual, and long term variations of snow cover extent and glacier mass balance. In turn, snow and ice also influence these larger scale circulation patterns. The linkage between the large scale air and moisture movement with solid phase water stores provides multi-directional feedback that further influences variability in both the circulation, and snow and ice accumulation, persistence and ablation. The objective of this symposium is to develop a discussion and understanding of the complex interaction between snow and ice, and circulation patterns at the large scale, and to synthesize the knowledge from various regions around the world

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JMS028 **Oral Presentation** **1534**

Glacier Systems in Northeastern Asia: projection of change by GSM scenarios

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Alexander Krenke

We considered continental (Suntar-Khayata and Cherskiy ranges located in the Pole of Cold area at the contact of Atlantic and Pacific influences) and maritime (Kamchatka under the Pacific influence) maintain systems. For them we constructed glacier balance curves (ablation and accumulation) basing on meteo-observation in the middle and end of 20th century and climatic scenarios on the 1st half of the 21st century (ECHAM and Hadley Center). The maps of spatial change (fields) of the equilibrium line altitude (ELA) are obtained, and their evolution for the mentioned 3 chrono-slices was assessed. The altitudinal distributions of the areas, covered with glacier ice, were built for present and future state of the glacier systems taking into account the correlation of the change of the ELA and glacier termini level. As a result, the possible changes of the areas and morphological structure of North-eastern Asia glacier systems and their mass balance were estimated. The paper presents also comparable characteristics of the glacier systems stability in the conditions of continental and maritime climate towards warming.

Keywords: glaciers, projection, scenario

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JMS028 **Oral Presentation** **1535**

The Increasing of Glacial Runoff in Response to Climate Warming in Glacier No.1 at the Headwaters of the Urumqi River, Tianshan Mountains

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Based on hydrological observations and calculations of water balance , the annual meltwater runoff of Glacier No.1 which locates at the Headwaters of the Urumqi River, Tianshan Mountains has been computed. It shows an elevated trend during the last several decades.The mean meltwater runoff depth is 936.6mm during the period of 1986 to 2001, comparing to 508.4mm during the period of 1958 to 1985. Data analysis shows that the proportion of liquid precipitation which can form runoff over the glacier surface has also been raised ,with the annual mean air temperature at the glacier terminus in the period of 1986 to 2001 increased by 0.5 to the period of 1958 to 1985.We also found that the ablation occurred in the position corresponding approximately to the equilibrium altitude in the glacier kept pace well with the glacier meltwater runoff. We conclude that the ablation on that altitude can represent the glacial meltwater runoff to a certain extent. Considering the climate shift in northwest of China, it is necessary to realize the glacial meltwater runoff sensitivity to climate change. We applied the degree-day model which has performed well for reconstructing mass balance of this glacier to simulate glacial meltwater runoff.

Keywords: glacier, runoff, degree day model

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JMS028 **Oral Presentation** **1536**

Snow distribution in HadCM3

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Snow water equivalent (SWE) is a useful variable for model evaluation as it requires both the precipitation and temperature schemes to be correct. Most studies comparing model and observational data at the continental scale use areal mean SWE as a comparison, whereas this study examines the differences in spatial distribution. The only global gridded datasets of SWE are from passive microwave sensors on satellites. This study uses SWE retrieved from SSM/I as it has the longest record. Although there are concerns about the sensitivity of the retrieval to snow grain size, it is argued that these effects are minimised when examining the data at the continental or hemispheric scale. Model data comes from HadCM3, with comparisons to the HiGEM and ECHAM5 models, and the ECMWF's 40 year re-analysis. 10 year monthly average SWE from both the satellite and models is examined. Although the mean northern hemisphere SWE is reasonably similar from both sources, examining the distributions shows large disagreements. Much deeper snow is found along coasts in the model than in observations. Over Siberia the satellite data shows high values (~150mm) and the model shows low values (~50mm). Runoff data from Siberian rivers is shown to support higher values than in the model, though the observations may be subject to some overestimation due to depth hoar. Data from other models is presented which show similar distributions to HadCM3, though the latter is the most different to the observations. The difference is due to circulation rather than relief, as similar distributions are seen in higher resolution models with more realistic representation of topography. Studies have suggested that snow in Siberia is a result of storms originating in the Arctic, and moisture advection from other land surfaces. These processes in the model are investigated.

Keywords: snow water equivalent, northern hemisphere, hadcm3

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JMS028 **Oral Presentation** **1537**

CLimate forcing due to black carbon and dust depositions on snow surface

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Climate change due to greenhouse gases is predicted to be significant in the cryosphere and thus the studies on mechanism of radiation budget on snow/ice surface are important for accurate climate simulation in the cryosphere. Since the snow albedo is one of the most important parameter to control the radiation budget on snow/ice surfaces, an understanding of physical process of snow albedo and the modeling (and/or the parameterization) is necessary. Snow albedo essentially depends on snow impurities (water-insoluble solid particles contained with light absorption), snow grain size, geometric illumination condition, and the atmospheric condition. We then developed a physically based snow albedo model, which predicts the visible and near infrared albedos as functions of the concentrations of black carbon (BC) and mineral dust for snow impurities, snow grain size, and solar zenith angle for direct and diffuse components of solar radiation. The concentrations of the BC and mineral dust in the snow are calculated from wet and dry depositions of these atmospheric aerosols using a chemical transport model. Since the light absorption efficiencies of the two snow impurities are different, we introduced a snow impurity factor (SIF), which is calculated from those mass absorption efficiencies and mass fractions of impurities. The physically based snow albedo model is incorporated into the land surface process (LSM) in a chemical transport model named as Model of Aerosol Species IN the Global Atmosphere (MASINGAR). The result of climate simulations with MASINGAR for the snow contaminated case and snow impurity free case showed that radiation budget difference at the top of the atmosphere between both the cases is +0.7 W/m2 (positive value means the heating due to snow impurities) for all sky conditions and +1.12 W/m2 for clear sky. These values are comparable to the direct or indirect effect of radiative forcing due to the atmospheric aerosols. The future possible increases of BC and dust emissions would enhance the snow albedo reduction and thus snow melting in theArctic.

Keywords: snow albedo, black carbon, radiative forcing

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JMS028 **Oral Presentation** **1538**

Testing a model of heat/water exchange in the snow taking into account its metamorphism

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A one-dimensional model of snow cover is developed based on SVAT model SPONSOR, involved in PILPS, SnowMIP and other international intercomparison projects. The model includes numerical solution of the heat transfer equation by semi-implicit scheme, phase transformations within the snow cover and on its boundaries, densening of the snow due to its accumulation, and main features of snow metamorphism as a result of specific processes. Among the latter, crust and depth hoar formation and disappearance are parameterized, as the most important factors influencing the snow heat conductivity. The snow model is included in SVAT model, with the latter providing heat and water fluxes at the snow boundaries, as well as all characteristics of hydrothermal regime in the soil, turbulent fluxes in the atmospheric boundary layer, etc. The snow model has been tested in a set of numerical experiments against observed data from quite different environments such as Franz Josef Land in the Arctic and alpine sites in Western Tien Shan mountains in Central Asia. Forcing parameters included meteorological variables (air temperature and humidity, wind velocity, precipitation, solar radiation or cloudiness). Regular snow pits with observations of snow stratigraphy, its temperature profiles, crystal types, snow density and other characteristics were also carried out during the field campaigns. The model has demonstrated its ability to reproduce main features of the seasonal snow evolution, including the densening, loosening in certain cases, and melting. In specific weather conditions, however, the models ability to reproduce snow evolution is rather limited. The work is supported by INTAS (grant 03-51-5296), NATO CLG project 981942, and Division of the Earth Sciences of the Russian Academy of Sciences, program 11, project 6.

Keywords: snow, model, metamorphism

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JMS028 **Oral Presentation** **1539**

Snow accumulation in four large-scale river basins of Northern Eurasia: relations to the recent climate changes and impact on runoff variations.

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Composite analyses, based on daily snow depth, snow water equivalent (SWE), time series of Northern Hemisphere circulation patterns and monthly discharge of four river basins (Volga, Ob, Yenisey and Lena) are used to examine spatial/temporal peculiarities of snow accumulation over the large-scale river basins and their relation to the dominant atmospheric variability modes of the recent climate changes in order to asses its impact on annual runoff variations. Patterns of the spatial distribution of the following parameters: snow accumulation (mean snow depth and SWE) for the end of winter; correlation coefficients between snow accumulation and annual runoff; average snow accumulation anomalies, associated to the anomalies of various circulation indices, have been derived for the studied river basins. Comparison of the patterns corresponding to various basins and analysis of runoff/snow-depth cross-correlation functions demonstrate that impact of snow accumulation variations on annual river runoff differs in various basins. It depends on relative share of winter and summer precipitation, as well as spatial peculiarities of snow accumulation over the basing. North-Atlantic oscillation (NAO) is recognized as a dominant atmospheric circulation mode of recent warming in Northern Eurasia. Although the investigated river basins extend over the regions of influence of different circulation modes, for almost all of them NAO signal seems to be significant in the interannual variations of the basin-averaged snow depth. Quasi-decadal variations of snow depth are reflected by the annual runoff to some extent over all of the studied basins. However, long-term changes of snow accumulation on the one hand and runoff on the other hand do not coincide in Ob and Lena basins, probably due to prevailing share of summer precipitation variations. For Volga and Yenisey basins the positive trend of runoff since 1970s is caused by increased snow accumulation associated with positive phase of NAO. At the same time, variance spectrum and coherency function between Volga annual runoff and winter NAO index show that quasi-decadal fluctuations is negatively correlated to NAO. The latter can be explained by negative snow depth anomalies over the south-west of the basin associated with positive phase of NAO. This work has been supported by the Russian Foundation for Basic Research (grant 06-05-64349) and Division of the Earth Sciences of the Russian Academy of Sciences, program 11, project 4.

Keywords: snow accumulation, river runoff, atmosphere circulation change

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JMS028 **Oral Presentation** **1540**

On snow cover variability in alpine terrain

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In terms of water availability for mankind, snow dominated regions are important in their function of collecting, storing and delayed release of water. The spatial distribution of snow is one factor within this context. A profound knowledge of this distribution is a prerequisite for predicting an accurate energy balance of the surface and, consequently, correct melt rates. Within this context snow transport, precipitation and snowvegetation interactions are the steering factors with respect to the accumulation and ablation patterns of snow in alpine mountain environments. Within the presented study a numerical parameterisation for the spatial snow variability was developed, to be applied with a SVAT model on the 1km scale. We used the snow transport model SnowTran3D in combination with MM5 (Penn State University - MM5 model) generated wind fields for the distributed simulation of the seasonal snow cover evolution. The original 200 meter MM5 results were downscaled to a 50 meter resolution by using a semi-empirical approach which accounts for the elevation difference of model and real topography, as well as aspect, inclination and vegetation. Hereafter, static and quasi static parameters like topography, vegetation, average wind speed and direction were correlated with the modelled snow cover distribution on the 50 meter scale. The results were used for determining a representative subscale variability of the snow cover for any 1km grid cell of the SVAT model. We developed the regionalisation tool subsnow_ALPS for this purpose. First results of the influence of sub scale snow heterogeneities on the water balance will be shown.

Keywords: snow, alpine, variability

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JMS028 **Oral Presentation** **1541**

Impact of disturbed desert dust on mountain snowcover duration

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The surface shortwave radiative forcing of absorbing desert dust in mountain snow cover of the world's ranges and the implications for snow cover duration are poorly understood. Whereas dust loading in the atmosphere temporarily decreases the surface irradiance through scattering and absorption, dust loading at the snow surface persists well beyond the atmospheric presence of the dust event. Absorption by dust in the snow increases near-surface snowpack temperatures, decreasing the column cold content of the snowpack and increasing the energy available for melt. Dust presence therefore positively forces tropospheric temperatures through direct and indirect effects. Enhanced absorption represents the direct effect of dust deposition on the regional radiative budget. Indirect effects occur as associated increases in snow grain size (further lowering albedo) and the more rapid snowpack ablation that reveals a more absorptive substrate. These effects and their implications for snowcover duration, while conceptually known, have not been quantified in large part because of the lack of detailed radiation measurements that separate the radiative impacts of dust from changes in grain size. Our monitoring of surface radiative fluxes and discharge began in winter 2005 at alpine and subalpine meteorological towers in the San Juan Mountains, Colorado, USA. In years 2003-2005, we observed 3-4 significant dust deposition events per year in winter and spring, whereas after the weak monsoon and intense drought in the Colorado Plateau through winter 2006 we observed 8 significant depositions including the multi-state heavy deposition on February 15 not seen in 20 years. Spring season mean daily surface shortwave radiative forcings (direct + indirect effects) due to dust increased from 25 W m-2 in 2005 (mean desert precipitation) to 49 W m-2 in 2006 (intense drought). Snowmelt modeling showed that in 2005, dust radiative forcing affected a 22-33 day earlier melt whereas in 2006 dust radiative forcing affected a 18-35 day earlier ablation but for a 15-35% less snow water equivalent. Given widespread disturbance of the western US in the mid to late 1800s and the associated dust emission, current snowcover duration is likely order one month shorter than prior to the disturbance. With continued soil disturbance and projected drought in the southwest US under global warming scenarios, the 2006 season may represent a new regime of dust forcing of radiative and hydrologic systems in the intermountain west.

Keywords: snowcover, dust, radiative forcing

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JMS028 **Poster presentation** **1542**

Polar areas of Northern Eurasia: tendencies of extreme snow accumulation in conditions of a modern climate

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The basic purpose of researches is revealing tendencies of changes of a snow cover of Northern Eurasia in conditions of modern changes of a climate. The primary goal of researches consists in revealing seasonal variations in conditions of regional variability of a climate. In result the seasonal features of snow storage are revealed for Northern Eurasia.The monthly increment of snow storage has the tendency to reduction in the autumn and positive trend in January (0.156 mm / year). Thus, the basic role in the tendency of large-scale increase of snow storage gradually passes from autumn months to January. This situation is characteristic first of all for the north and the center of East European Plain, Turan lowlands and the south of Siberia. For various ranges of NDVI seasonal tendencies of snow cover variability are revealed for Northern Eurasia to the north 50. Wood vegetation bring the most essential contribution to the long-term tendency of snow storage increase. The area with extreme of snow sroragve (exceeding a standard deviation) grows from November by February. Long-term changes of the area of extrema of a snow cover are negative in the beginning of winter and positive in January and February. Process corresponds to long-term reduction of the area where the temperature of air in the beginning of winter exceeds a standard deviation. Thus, the limit of snow increase at increase of winter temperature has already come for extreme snow storage at extreme temperature of the beginning of winter. In case of double standard deviation for all parameters it is possible to speak about the current achievement of a limit of snow storage increase.

Keywords: snow, climate, extremes

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS028 **Poster presentation** **1543**

Consequences of climate change in the steppe land of Armenia

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Microclimatic changes in steppe lands of Armenia are result of intensification of processes of the desertification, essential infringement of water balance, change of atmospheric precipitates and moisture load of ground. Climatic changes become the reason of change of structure and distribution steppe ecosystems as species composing coenosis differently to react to new conditions. At the same time, on a background of anthropogenic influence there can be degradation and a fragmentation of natural habitat of species. Inspection of mountain steppe land of Armenia have displaied displacement of floristic structure aside aridity, therefore the vital potential of highly nourishing species is gradually reduced. Discussing influence of climatic changes on vegetation it is necessary to take into account coherence of natural and anthropogenic factors. In fact cutting down of woods, change of land areas - all this in turn influences a climate.

Keywords: steppelands, desertification, atmospheric precipitates

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JMS028 **Poster presentation** **1544**

Interaction between newly formed snow cover and lower PBL in the Kanto Plain

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Shallow snow cover produced by extratropical cyclones passing along the south coast of Japan, causes serious damage to transportation systems in large cities such as Tokyo and Yokohama on the Kanto plain because snow cover seldom appears there. The Kanto plain is so temperate that it is essential to keep the lower PBL cold for the formation of snow cover, because fallen snow particles must not melt completely before reaching the ground. An appropriate estimate for solid precipitation as a source of snow cover is necessary to reproduce correctly snow cover in a numerical model. JMA cloud resolving Non-Hydrostatic Model (JMANHM, in short, NHM) can predict precise precipitation of rain, snow and graupel. The operational NHM in the default usage (hereafter, referred to NHM/DEF), however, cannot deal with snow cover evolution. Meanwhile, a new land surface model MRI/JMA-SiB (hereafter referred to MJ-SiB), which consists of a vegetation canopy of SiB, newly designed snow sub-model and soil one, has the ability to forecast adequately snow cover time change. On 21 Jan. in 2006, a cyclone produced a large amount of snowfall in a band region of about 50km adjacent to the coast of the Kanto plain, and new snow cover 10-20cm in depth was formed. Numerical simulation was carried out using the NHM with MJ-SiB (NHM/MJ-SiB) and NHM/DEF to find interaction between new snow cover and the lower PBL. The results are summarized as follows. 1) When the cyclone was near the plain, SE wind was predominant above the PBL and a large amount of snow particles was produced there. Some fell over the band region with incomplete melt, and the others over the coastal region with complete melt. 2) Simultaneously, at first a weak N wind appeared in the PBL up to an altitude of 1 km, then a moderate NE wind did. Both winds originated from the Tohoku district, located to the north of the plain. The N wind was coming over snowy land and remained cold. On the other hand, the latter initially flowed out the Pacific Ocean as a NW wind, then was deflected clockwise by the cyclone and finally re-landed as the NE wind. The initial dry cold air was modified as it was warmed over the Ocean. 3) In the band region, new snow cover was made by snow precipitation with incomplete melt due to the low temperature of the weak N wind. The succeeding warmed NE wind was again cooled by the appearance of new snow cover, in proportion to the fetch from the seashore. Thus, the longer the fetch is, the more ratio of snow in sleet and snow water equivalent resulted. In contrast, in the coastal region air, temperature in the lower PBL was high enough to melt all snowfall. 4) Once very shallow snow cover was laid, snow cover acted as a cold heat source for the lower PBL. This is indicated by a good accordance of surface temperatures by NHM/MJ-SiB with observations, and higher surface temperatures in the case of no snow cover by NHM/DEF.

Keywords: snowcover, mri jma sib, jmanhm

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JMS028 **Poster presentation** **1545**

Snow cover occurrence in central European lowlands under Northern Hemisphere teleconnection patterns

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Four teleconnection patterns (North Atlantic Oscillation NAO, East Atlantic pattern EA, East Atlantic/Western Russia EA/WR and Scandinavia SC) persistent in the Euroatlantic region are taken into consideration and their influence on snow cover occurrence in 35 central European lowland stations is investigated. The correlation coefficient (r) between the monthly number of days with snow cover and monthly circulation indices is computed and mapped. Anomalies in the monthly number of days with snow cover at positive/negative extremes of each teleconnection pattern are calculated and tested. The most significant negative relationships are found between the NAO index and snow cover duration (r up to -0.7 or even -0.8 in northwest Poland and northeast Germany). The difference between the number of days with snow cower during positive and negative NAO extremes is statistically significant and reaches 18 days in January. Three remaining teleconnection patterns have much less impact on snow cover. Some significant positive snow signals are found for the negative phase of EA in January and February, and for negative phase of EA/WR in December. The Scandinavian anticyclone in the SC positive phase is favourable for snow cover duration in February and March, but only in the north eastern edge of the studied area.

Keywords: europe, snow, circulation

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JMS028 **Poster presentation** **1546**

Impacts of synoptic weather condition on the features of glacier melting in Chilean Patagonia

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The development of peculiar micro-climate over glaciers should be affected strongly by larger-scale weather. In order to clarify the effects of distinct difference in synoptic weather condition on the features of glacier melting, meteorological observations were carried out on Glacier Exploradores, an outlet glacier from Northern Patagonia Icefield under maritime climate in the austral summer of 2006/2007. During the observation period, two typical weather conditions were found on the glacier: Rainy or cloudy days with winds in the up-valley direction from the Pacific coast (condition A) and Clear days with winds in the down-valley direction (condition B). Under the condition A, surface melt rate of the glacier tended to be large due to strong and humid wind, even when global radiation was small. Under the condition B, in contrast, the contribution of turbulent heat fluxes for melting tended to be very small due to development of the glacier boundary layer. This implies that some differences can be found in the spatial variation of heat balance on the glacier surface between two weather conditions. Thus, the frequency of each weather condition and its change should have a strong influence on mass balance of the glaciers in this region.

Keywords: glacier, climate, patagonia

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS028 **Poster presentation** **1547**

Snow cover depth in eastern Europe in relation to circulation patterns at the 500 hPa level

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The rotatedprincipal components of the 500 hPa geopotential heights in the Euro-Atlantic sector were used as the indicators of circulation type intensity. The following four patterns were taken into consideration: the North Atlantic Oscillation (NAO), Scandinavian (Sc), East European (EE) and Central European (CE). The daily snow cover depth data for the years 1951-1995 collected from 71 east European stations were used to calculate the monthly increases in snow cover depth during the entire snow period and the monthly decreases in snow cover depth during spring. Maps of linear correlation coefficients between the monthly increases/decreases in snow cover depth and the rotated principal components show the areas of positive and negative relationships. The positive and negative extremes of each circulation type were analysed and positive and negative snow cover signals were indicated on the maps. The strongest impact of the atmospheric circulation on changes in snow cover depth was observed in the south and west of the studied area. The EE (mainly in February) and CE (particularly in January) circulation pattern were found to have the greatest impact on the increase in snow cover depth there. The NAO impact on the snow cover depth in eastern Europe is limited to the beginning and the end of winter, mainly in the western part of the studied region. Snow cover is a climatic parameter of low variability in northeasternEurope and it shows low sensitivity to changes in the atmospheric circulation. The Sc pattern is one of the greatest importance for snow cover increases there. The decreases in the snow cover depth observed in spring are related to the NAO, Sc and EE patterns, the latter being the most important for the snow cover depth fluctuations over the northeastern Europe in April.

Keywords: europe, snow, circulation

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JMS028 **Poster presentation** **1548**

Dynamics of snow formation in the Western Siberia

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The importance of observations of snow formation in all cryosphere processes in the permafrost zone is explained by its response on all biotic and stagnate landscape substances. The most relevant impact of snow is that on the upper layers of lithosphere in the areas of high-temperature permafrost rock. The integrated observations of dynamics of snow formation in seasonal and everlasting permafrost conditions from forest-steppe subzone till tundra zone were taken in 2005-2006. The peculiarities of the depth of snow layers on the zonal and latitudinal levels were discovered, as well as stratification and dense snow distribution. The impact of cryosphere factors, especially the snow effect on the conifer leaf fall in winter and its snow distribution depends greatly on climatic factors, such as cyclone activity. The biggest amount of the leaf fall in winter is observed after a thaw. The total of the leaf fall in conifer woods in a forest-steppe subzone in winter can be equal to the amount of the leaf fall during the days with the positive air temperature. On the one hand, the snow effect as an essential landscape component in awide variety of natural systems was studied by example of altern distribution of snow melt and permafrost. On the other hand, the vegetation effect on snow distribution and depth was investigated. As a result in sporadic and insular permafrost there was a relationship between depth and temperature of the permafrost with the snow depth which is determined by the type of vegetation. In conclusion the simultaneous degradation and aggradation of the permafrost determined by the snow depth can be found on a limited area with the daily high-temperature of permafrost. Thus the snow formation is a function of the variety of landscape factors, including vegetation as the key factor.

Keywords: dynamics, snow formation, vegetation

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JMS028 **Poster presentation** **1549**

Regional features of microwave interaction with snow cover on an example of the North of the European part of Russia

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Definition of characteristics of a snow cover remains a problem at interpretation of remote data. It, mainly, is connected with the big existential variability of properties of a snow cover, and also because of difficulty of comparison of dot ground supervision with the remote measurements having the low resolution, but a global covering. Remote measurements of radiophysical parameters of a snow cover which are spent now, show, that radiobrightness temperature strongly depends on physical properties and stratigraphy of snow thickness. In the report it is discussed, developed by the authors, structurally-dependent model of emissivity of a snow cover. The snow cover is represented the environment consisting from discrete scatterers. In case of a dry snow scatterers are grains of an ice are. For a wet snow two geometrical configurations water components are considered: a mix of grains of an ice and water drops, and also a mix of grains of the ice covered by a water film, and water drops. It is supposed, scatterers have the spherical form and their sizes are subordinated to log-normal distribution. Results of modeling calculations are compared to data of radiobrightness temperatures of a snow cover of device SSM/I of program DMSP and compared to distribution real snow level and temperatures. Satellite data on brightness temperatures DMSP SSM/I for flat territories of the north of Eurasia are given by The Global Hydrology Resource Center (NASA). Now there is a regular accumulation of these data in Space Research Institute RAS and total amount of the saved data now makes size 150 Gb. The main feature of a created database is the animation ideology of its construction and creation popular WEB interface. The software allowing according to SSM/I in format GRID to choose value of brightness temperature for concrete points on a terrestrial surface with accuracy + - 0.25o on latitude and a longitude, and by averaging on a surface 0.5o x 0.5o. Distribution of a snow cover and actual temperatures of air was estimated on corresponding data of supervision of meteorological stations. The comparative characteristic of existential variability of modeling, satellite and ground data is lead for key sites of Northern Eurasia (northern part of East European plain). Similarity is estimated for satellite radiobrightness temperatures of different ranges, ground actual temperature of air and height of snow cover.Studies are executed within IPY project "Northern Snow Cover Accumulation and Melting During the IPY as a Part of Interannual Variability - their causes and consequences", scientific leader academician V.M. Kotlyakov; and at support of the Russian Fund of Basic Researches (project 06-05-65195 "Definition and comparison of snowpack spatial structures from the microwave satellites data and on ground measurements in natural zones of Russia).

Keywords: microwave, interaction, snow

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JMS028 **Poster presentation** **1550**

Interannual variability of the Aleutian and Icelandic Lows in an ensemble GCM simulation forced by snow cover satellite observations

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N. Kvamst

We have performed a suite of GCM simulations spanning two decades (1979-2000) to attribute circulation anomalies to changes in snow cover extent, with a focus on the northern hemisphere high latitudes. Observed snow cover derived drom satellite data has been retrieved from the NISDC, and nudged weekly into the GCM. Control simulations with prognostic or climatological snow variableshave been also performed. Our simulations are ensemble simulation with five members, and are carried out at a T63 resolution. We have examined the connection of snow cover variability over Eurasia withseveral features of thenorthern hemisphere winter circulation, in particular the Aleutian and Icelandic lows. We find that nudging of realistic snowcoverconsiderably improves the hindcast and the representation of the Aleutian-Icelandic Seesaw in the model. Wediscuss gains in potential predictability in winter, resulting from thesnow nudging.

Keywords: snow, climate, atmospheric modelling

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JMS028 **Poster presentation** **1551**

Regional patterns of snow water equivalent in the Colorado River Basin using snowpack telemetry (SNOTEL) data

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Jeffrey E. Derry

Typically the grouping of station measuring snow properties is based on spatial proximity or has been restricted due to the temporal resolution, in particular the monthly sampling of snow course data. This investigation utilizes daily data from 216 snowpack telemetry (SNOTEL) stations located in and around the Colorado River Basin over a 15-year period (1991-2005) to group stations. The grouping or clustering identifies regions of homogeneity based on their patterns and variability. To achieve this, data were submitted to a self-organizing map (SOM), a particular application of artificial neural networks. This methodology represents a learning algorithm that is non-linear, non-parametric, unsupervised, and learns through an iterative training process. The number of clusters can be specified to the SOM based on the level of generalization desired. A SOM consisting of a four, six, nine, and sixteen-cluster were constructed as well as a six-cluster derived from snow pack deor variables (peak snow water equivalent (SWE), length of snow season, April 1st SWE, etc.) and physical variables (elevation, aspect, distance to moisture source, etc.) for each station. Results show an unbiased clustering of stations defined not by geographic location, but by each stations particular SWE variability. The established snow climatologies show generalized homogenous course-scale clusters, particularly in Wyoming and Arizona, which by and large become more spatially localized at finer-scales of classification. Overall there are no definitive spatial patterns to the climatologies, indicating that local topographic variables dominate SWE processes. Deor variables that best represent daily time-step classifications is peak SWE followed by April 1st SWE and physiography.

Keywords: snotel, coloradoriver, swe

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JMS028 **Poster presentation** **1552**

The relationship between physiographic variables and snow water equivalent from snow telemetry (SNOTEL) sites in the Colorado River Basin, USA

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Roger C. Bales

The relationship between snow water equivalent (SWE) and a variety of physiographic variables for the Colorado River Basin, USA was explored through a multi-variate regression. These variables include location, slope and aspect at different scales, derived parameters to indicate the distance to sources of moisture and proximity to and characteristics of obstacles between these source areas of snow accumulation, and forest density. A weekly time step of snow telemetry (SNOTEL) SWE data from 1990 through 2005 was used. The most important variable was elevation. Slope at a medium scale (15 km2) and at a regional scale (81 km2) were postively correlated with SWE. The seasonal variability illustrated the necessity to formulate the regressions for each time step. The interannual variation in the relationship between SWE and physiographic variables partially corresponded with snow accumulation and the El Nio Southern Oscillation cycle, yet the variability across the basin in accumulation trends reduced this correlation.

Keywords: coloradoriver, snotel, swe

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JMS029 **1553 - 1562**

Symposium
Snow Avalanches Field Observations and Modelling (UCCS Symposium hosted by IAMAS)

Convener : Dr. Karl Kleemayr
Co-Convener : Dr. Sovilla Betty, Dr. Andreas Schaffhauser

Most of the currently used avalanche simulation models are either statistical run-out models that are restricted to avalanche tracks that fit into different categories, or one-dimensional centre of mass models. Additionally, the avalanche path has to be prescribed by the user. Field evidence for verification is difficult to obtain and therefore rare. The approaches simplify very much and cannot describe the deformation of the avalanche body. Two- and three-dimensional models based on fundamental fluid mechanics are able to predict the avalanche track as well as lateral spreading and run out distances, and request for additional verification criteria. The session is to define the state of the art of determining the snow pack distribution in a high temporal and spatial resolution

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JMS029 **Oral Presentation** **1553**

Estimation of snow accumulation and melt based on Runoff Model and MODIS-TERRA DATA

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Water Resources Enginnering M.S Student

Samira Moradi Rasooli, Mahin Jamali

In this research, based on 4 storages conceptual rainfall runoff model, the effect of accumulation and melting of snow on the runoff using modeling, GIS and RS techniques has been investigated. A basin at the upstream of LAR dam in the north of IRAN and in the south of Alborz mountains range has been selected for this study. LAR dam is one of resources that supply TEHRAN metropolis water demand. LAR river basins area is 734 square kilometer and included altitude ranges from 2500 to 5000 meter from sea surface level. Because of the high altitude and lack of access way there isnt any snow gage station in the study area but there is one hygrometry station at the out let and some rain gages around the study area. The main part of precipitation is as snow in the winter. The structure of developed conceptual rainfall runoff model is based on 4 storages including snow storage, surface water storage, lower zone storage and groundwater storage. Snow storage included 20 sub storages with deferent elevation. Snow storages parameters including temperature laps rate, threshold temperature that shift between precipitation in the form of rain and snow, degree day approach for snow melt calculation, precipitation laps rate has been described. Auto calibration of rainfall runoff model including precipitation and snowmelt model for the study area is the main objective of this research that simulates monthly runoff. Auto calibration of model parameters has been done by developed global optimization method named shuffled complex evolution (SCE). Then we described a method for snow cover mapping using MODIS/TERRA data and a procedure to estimate retrospectively the accumulation snow water equivalent volume with the rainfall runoff model. The model calibrated it for the period of 1989-2001. The snow cover obtained using MODIS_TERRA images, Digital Elevation Model (DEM) and conceptual rainfall runoff model. Graphical display of two measured and computed runoff and evaluated criterion shows that simulation is successful. As snow is the main water in the region, an accurate estimation of snow equivalent is necessary.

Keywords: snow accumulation, snow melt, lar river basin

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JMS029 **Oral Presentation** **1554**

A coupled stress and energy criterion for natural and artificial triggering of dry snow slab avalanches

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Chiaia Bernardino, Cornetti Pietro, Cardu Marilena, Chiaravallotti Lorenzo

The paper presents a new coupled stress/energy criterion for triggering of dry snow slab avalanches. The snowpack is considered as a snow stratifications made of a relatively thick, strong and stiff slab over a thin weak layer with very low mechanical properties if compared with the snow of the slab. Below the weak layer is a cohesive basal layer, which can be represented either by the soil or by previously fallen snow. Inside the weak layer we consider the presence of the super-weak zone that acts as stress concentrator. Because of some reasons (snow fall, skiers, etc), the original basal crack corresponding to the super-weak zone starts propagating along the weak layer beneath the slab under mode II and mode III loading conditions. The presented model considers a plane geometry, so that only mode II is attained at the crack tip and the residual shear stress r is assumed to be negligible. The definition of the coupled trigger model is based on a shear lag model (Stang and others, 1990; Pugno & Carpinteri, 2003) for composite materials, considering two different approaches to identify the failure condition: the stress and the fracture mechanics approaches. The critical shear stresses obtained by a stress criterion ((τN)T) and energy criterion ((τN)E) are both depending on the half-length of superweak-zone a, Youngs modulus and thickness of the slab and of the weak layer. The peculiarity of the model is the definition of the characteristic length, depending on the snow slab height (H), the weak layer thickness (h), the effective Young modulus (E in plane strain condition) and the weak layer shear modulus (Gw). On the basis of what is stated in Leguillon (2002) and Cornetti et al. (2006) it is proposed that the two criteria can be coupled into a unique failure criterion by assuming that both must be contemporary fulfilled to have crack propagation. In other words, fracture is energy driven but a sufficiently high stress field must act in order to trigger crack propagation and, consequently, avalanche release. Each single criterion is a necessary condition for crack propagation, whereas their contemporary fulfilment represents a sufficient failure condition. The failure criterion is discussed considering typical values of mechanical properties of the snow and of the slope and compared with McClungs energetic model (1979). In particular the failure criterion is usually more conservative than McClungs model (1979), but for the thickness of the weak tending to zero, the two models coincide. The weak layer thickness with the highest triggering probability corresponds to the values which are detected more frequently in the field. Considering the specific energy of some different kind of explosives and evaluating the transmission performance of the snow layers in the snowpack, the coupled criterion is applied to artificially induced triggering. Calculating the equivalent load in the case of the stress criterion and the extra-energy supply in the case of the energy criterion due to the action of the explosives, the model confirms the efficiency of detonation explosives for artificial triggering of dry snow slab avalanches.

Keywords: snow slab avalanches, coupled criterion, artificial triggering

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JMS029 **Oral Presentation** **1555**

CFD Simulation of Snow Drift in Alpine Environments for Operational Avalanche Warning

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Due to increasing development of Alpine environments by transport and tourism the forecasting of avalanche danger becomes more and more important. The protection of civil facilities and human lives is one major aim of avalanche forecasting. The snow depth at mountainsides and the dead load of snow slabs are important factors which contribute to avalanche danger. In addition to fresh fallen snow, snow drift contributes a lot to the amount of snow at mountainsides. Mainly leeward the snow depth is determined by the strength of drifting snow. Cornices and snow banks are primarily formed by snow drift. If the boundary shear stress acting on the snow cover, which is induced by the wind, exceeds a certain threshold, snow will be entrained. On the contrary, if the flow does not exert enough shear stress, snow is deposited. Hence, erosion and deposition zones are built, whereby the geometry of the snow pack changes. These deformations of the shape of the snow pack couple to the wind field and thus the flow is changed by the new geometry. This coupling creates time dependent erosion and deposition zones. The amount of snow grains, which can be transported by the flow, contributes additionally to snow drift occurrences. An increasing wind speed raises the amount of drifting snow. If a fence slows down the flow, snow will be deposited by a decreasing amount of drifting snow. Furthermore, there is a need to study the influence of time varying boundary conditions which are obtained by including local weather models. The direction and velocity magnitude of the wind are derived from Inca and hooked into the commercial computational fluid dynamics code Fluent . Finally, the numerical simulation of complex snow drift processes has to challenge with time dependent geometries of the snow cover and particle transport phenomena. Snow erosion and accumulation are determined by boundary shear stress criteria leading to a deformation of the snow cover.

Keywords: computational fluid dynamics, avalanche protection, snow drift

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JMS029 **Oral Presentation** **1556**

Remote sensing based retrieval of snow cover properties - the GALAHAD project

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In order to overcome the restrictions of conventional observational methods (mainly the inadequate characterisation of spatial and temporal variability of the observed quantities) novel remote monitoring techniques like terrestrial laser scanning as well as ground based and space borne interferometric synthetic aperture radar (SAR) are operated within a European Union funded 6th FP project (N. 018409) called GALAHAD (Advanced Remote Monitoring Techniques for Glaciers, Avalanches and Landslides Hazard Mitigation). For the experimental activity of the avalanche related topics of GALAHAD, an experimental test site in the Wattener Lizum (Tyrol, Austria) was equipped. Snow depth and snow water equivalent are key parameters in the assessment of avalanche hazards, for snow drift and avalanche modelling and model verification. While the laser scanner maps the spatial snow depth distribution, the SAR instrument can be used to retrieve snow depth and snow water equivalent. During special observation periods in winters 2005/2006 and 2006/2007 contemporaneously observations of the terrestrial laser scanner and the ground based C and S Band SAR are available. These remote monitoring data are compared with information obtained from continuous traditional field work. Pros and cons of the remote monitoring techniques are identified. Finally the potential of the techniques for the integration into snow and avalanche related applications are critically reviewed

Keywords: remote sensing, snow cover properties, galahad project

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JMS029 **Oral Presentation** **1557**

Two-phase avalanche simulation in a water tank based on a turbulent dense flow physical and numerical investigation

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The current paper describes the investigation on the efficiency of two avalanche breakers, namely a retaining dam and a coarse grid rack, on a fast dense or turbulent dense flow avalanche. The investigation was in a first step performed in a physical model based on the Froude similarity. The avalanche was generated phenomenologically similar to a prototype avalanche using a two-phase approach. Whereas for the avalanche material spherical lead particles were used the surrounding atmosphere was modelled by water in order to obtain equal densiometric Froude numbers both in model and prototype. The experimental work was performed in an inclinable laboratory flume of two meters length which resulted in a model scale for the investigated avalanche breakers of 1:100. Traditional avalanche simulations are used for large areas and therefore seem not to be able to resolve the turbulent and complex flow pattern in the vicinity of the avalanche breakers. Therefore a physical model was chosen for first tests. The results of the physical experiments helped to verify and improve the efficiency of the breakers. The investigation showed that the deceleration of the avalanche was higher with the coarse grid rack than with the full dam. This result also holds even if the length of the flume was too short to achieve a fully developed avalanche as turned out in the second numerical part of the investigation.In a second step 3D numerical simulations were performed and compared with results from the physical experiments. Two differing approaches were used namely a continuum simulation using a Bingham or Herschel-Bulkley fluid and a particle simulation. Both approaches were realized through the commercial code Flow-3D by Flow Science Inc.,Santa Fe, California. Simulations with both continuum approaches showed unsatisfactory agreement with experiments. The results showed that such simulations are not able to reproduce the dynamics of a turbulent avalanche. They seem only suitable for dense flow avalanches or mud flows. The particle approach using a Lagrangian description of the particles on a fixed Eulerian grid resulted in excellent agreement with experiments. In the particle approach a full coupling of fluid and particles, i.e. particle motion influences fluid motion and vice versa, and a random initialization of the particles in the inflow section was realized. After verification and calibration with the experiments the software can now be used to investigate the flow behaviour of 3D prototype avalanches. Also dynamic forces of avalanches on obstacles or buildings can easily be computed to improve their design. Thus the hybrid modelling approach overcomes the geometrical and topographic restrictions of a physical model.

Keywords: hybrid, turbulent, avalanche

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JMS029 **Oral Presentation** **1558**

Avalanche friction parameters and deposit characteristics from laser-scanner measurements performed at the Valle de La Sionne test site

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Vallet Julian, Bartelt Perry

We present laser-scanner measurements performed at the Valle de la Sionne test site during the winter season 2005-06. The measurements were performed before and after an avalanche release and allowed the determination of the snow cover spatial variability before the event as well as the determination of eroded and deposited masses along the avalanche path after the avalanche release with a spatial resolution of 0.5 m2. Using a digital terrain model, deposition depths have been associated to path slope angles. We found an exponential relationship between deposition depth and slope in agreement with previous studies on granular flow. A preliminary understanding of avalanche deposition processes is presented. Using Pouliquen granular mechanics theory, from deposition data we derived kinetic and stopping Coulomb friction coefficients for the studied avalanche.

Keywords: laser scanner, deposition, friction

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JMS029 **Oral Presentation** **1559**

Experiments at the Valle de La sionne test site: new advances in the field of avalanche dynamics

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The Valle de la Sionne experimental site has been in operation since the winter season 1997-98. During these years new methods to measure mass balance (photogrammetry and laser-scanner), flow velocities (doppler radar and optical sensors), impact and air pressures (piezoelectric and Pitot sensors) and density (capacitance sensors) have been developed and tested at the site. Numerous dense, mixed and powder snow avalanches have been recorded. We present an overview of 10 years experiments and the insights that the data has provided in the field of avalanche dynamics. Topics include: (1) rheology and the nature of energy dissipation in flowing avalanches, (2) the role of entrainment in avalanche motion and avalanche runout, (3) the magnitude of impact pressures and dependency on dimensionless numbers and (4) the formation of avalanche plumes and the shape of powder snow avalanche fronts. Our aim is to draw a global picture of avalanche dynamics using the experimental data collected at the site, question existing theories and outline new research directions.

Keywords: reology, mass balance, pressure

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JMS029 **Poster presentation** **1560**

RAMMS a modeling system for snow avalanches, debris flows and rockfalls

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The software package RAMMS combines three-dimensional process modules for snow avalanches, debris flows and rockfalls in one tool. Because the system is coupled to a GIS environment, RAMMS is a powerful, user-friendly tool for hazard mitigation studies in mountainous regions that are affected by gravity driven, rapid mass movements. The focus of this presentation will be on the application of RAMMS in snow avalanche hazard mapping, which involves predicting avalanche runout distances, impact pressure and flow velocities. The RAMMS process module to predict these values employs a TVD finite volume scheme that numerically solves the governing differential equations describing the depth-averaged motion of dense flowing avalanches in general terrain. Semi-automatic GIS based procedures for specification of release zones and friction values have been developed to simplify the input process. A special feature of the snow process model is specification of a snow cover which, depending on the mechanical properties of the snow, can be entrained by the avalanche. This allows an accurate modeling of the avalanche mass balance, which is especially important in mitigation studies involving catching and deflecting dams. Example calculations are presented as well as a short introduction into the debris flow and rockfall modules.

Keywords: modeling, gis, avalanches

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JMS029 **Poster presentation** **1561**

Reviving operational numerical avalanche prediction in Canada using hourly electronic weather sensor data

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Numerical avalanche prediction was used in highways avalanche forecasting in for ten years before changes in information technology infrastructure rendered the original numerical avalanche forecasting model incompatible and therefore obsolete. Now, these efforts are being renewed with greater automation by the use of electronic weather sensor data. Use of this data presents several challenges and opportunities. Automated hourly observations generate large datasets that require systems for filtering historic and current data, as well as fitness testing routines that avoid the problem of serial autocorrelation. Weather sensor data manipulation systems offer several advantages over traditional avalanche prediction models that are based on manual weather and snowpack data. Rapid dataset generation enables spatial scaling of predictions, easy generation and testing of memory variables, model comparison, and visual verification of predicted avalanche probability time series. These features will facilitate operational implementation of avalanche forecasting models for applied computer assisted avalanche forecasting in highways avalanche control programs across British Columbia, . The British Columbia Ministry of Transportation is currently running a pilot Avalanche Forecast System (AFS) that uses only electronic weather sensor data and incorporates all of the aforementioned capabilities. A nearest neighbour analysis is used to generate avalanche probabilities, however, the AFS data management systems could also be made to operate with classical linear and modern non-linear statistical prediction methods. Automated filters eliminate erroneous data dynamically, permit investigation of various prediction targets (such as natural avalanche occurrences, or avalanches of different size classes), and a jackknife cross-validation routine generates fitness statistics by selecting test cases that are not temporally autocorrelated. Visualizations of AFS forecasts compared with avalanche occurrences and posted hazard levels allow relation of probabilistic avalanche prediction output to hazard ratings. The AFS was applied operationally in Kootenay Pass, near Salmo, BC, where accuracy was 76%, and also at Bear Pass, near Stewart, BC, where accuracy was 79%. Variance in predictive accuracy between the two sites is partly attributable to differences in climate and avalanche frequencies, and largely due to the different explosive avalanche control measures used at each site.

Keywords: avalanche, prediction, automation

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JMS029 **Poster presentation** **1562**

Contribution of GIS technology to the avalanche zonation:the study case of Prati di Tivo (Gran Sasso dItalia, central Apennine)

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Pinuccio D'Aquila, With The Collaboration Of Leandro D'Alessandro

The paper presents the preliminary results concerning GIS environment modelling and elaboration of surveyed geomorphologic and snow data with the aim of contributing to the zonation of snow avalanche susceptibility.The research activities have been performed in the Prati di Tivo ski area (Abruzzo Region, Teramo District), localised on the northern slope of the Gran Sasso dItalia mountain range, with altitude ranging between about 1400 m asl and over 2900 m asl and are contributing to the definition of a previsional model, capable to elaborate the following data in the following steps. Step 1: derivation of a Digital Terrain Model (cell size: 55 m) from the vectorial ortophotomap of Abruzzo Region (year 1982) and automatic generation of the altimetry, slope and aspect maps (morphometric parameters) in order to produce, trhrough graphical overlaying, the zonation of the areas susceptible to snow avalanches. Step 2: map digitizing of the probable avalanche localization (CLPV, total number = 213), obtained by the direct monitoring of the area during the winter season 2003-2004 (70 avalanches) and by archive available data; in particular referable to 77 events included into the cadastre of the Meteomont Survey (several years from 1986 to 2004), to 28 historical events and to 38 avalanched detected by photo interpretation. All the avalanches have been mapped according to the methodology indicated by AINEVA (Interregional Italian Association of Snow and Avalanches) for the realization of the maps of probable avalanche localization (CLPV). Step 3: CLPV data elaboration, performing Kriging analysis and the successive graphic overlay, aimed at the zonation of susceptible areas of step 1. Step 4: after the zonation of step 3 , successive graphic overlay of the raster containing the spatial distribution of the detachment safety Index (Is = tangf/tanga), function of the ratio between the static internal friction angle (f), estimated for the snow cover also on the basis of literature value, and the slope (a). Step 5: control and validation of the cartographic product, obtained by the step 4, with the real cases of further 49 avalanches developed in the winter season 2005-2006 in the study area.Afterwards the model is going to be verified in other areas and implemented also in respect to other snow-meteorological parameters (thickness of recent snowfalls, wind transported snow, thermal rise), local geomorphologic features (lithology, attitude and roughness of the bedrock, stability, etc.) and vegetation (type, density, etc.).The model is easily updatable in real time, thanks to a toolset, ad hoc developed in GIS environment and, in perspective, will be able to provide a contribution in previsional terms.

Keywords: cartography of snow avalanche, snowavalanchelocation, avalanchesusceptibility

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JMS030 **1563 - 1576**

Symposium
Extraterrestrial Ice (UCCS Symposium hosted by IAMAS)

Convener : Prof. Manfred Lange
Co-Convener : Prof. Ralf Greve

Ice, either as H2O or CO2 ice (or other compositions) represents a common feature in the solar system, most notably, on the surfaces of the inner planets and as major constituents of the moons in the outer solar system. Knowledge about the occurrence of ice either at the surface or inside the planetary bodies stems primarily from astronomical and satellite observations of their surfaces and from measurements of geophysical parameters that reveal information on their internal structure. Little is known about the exact properties, the development and the present dynamics of ice deposits on extraterrestrial planets. This symposium is intended to provide an overview about our current understanding about extraterrestrial ices, their main characteristics and their development

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JMS030 **Oral Presentation** **1563**

Chemical differentiation of Europa and Callisto: evidence for subsurface oceans

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Victor Kronrod

Models of the internal structure of completely differentiated Europa and partially differentiated Callisto have been constructed on the basis of Galileo gravity measurements, geochemical constraints on composition of ordinary and carbonaceous chondrites, and thermodynamic data on the equations of state of water, high- pressure ices, and meteoritic material. Our results show that the bulk composition of the rock-iron core of Europa may be described by material approaching the L/LL type chondrites in composition, but cannot be correlated either with the material of CI chondrites or H chondrites. The allowed thickness of Europa's H2O layer ranges from 115?10 km (6.8?0.6% of total mass) for a differentiated L/LL-type chondritic mantle with a crust to 135?10 km (7.9?0.5%) for an undifferentiated mantle. We show that Callisto must only be partially differentiated into an outer ice-I layer, a water ocean, a rock-ice mantle, and a rock-iron core (mixture of anhydrous silicates and/or hydrous silicates + Fe-FeS alloy). Rock-iron core radii, depending on the presence or absence of hydrous silicates, do not exceed 500-700 km, and the ice content in the ice-rock mantle is between 35 and 42 wt%. Taking into account the H2O content in hydrous silicates, the total amount of H2O in Callisto is found to be 48-55 wt%. The surface temperature of Callisto is expected to be 100-112 K. Assuming conductive heat transfer through the ice-I crust, heat flows were estimated and the possibility of the existence of a water ocean in Callisto was evaluated. The thickness of the ice-I crust is 135-150 km, and that of the underlying water layer, 120-180 km. The maximum thickness of the outer water-ice shell is up to 270-315 km. The results of modelling support the hypothesis that Callisto may have an internal liquid-water ocean. The correspondences between the density and moment of inertia values for bulk ice-free Io, rock-iron core of ice-poor Europa, and rock-iron cores of Ganymede and Callisto shows that their bulk compositions may be, in general, similar and may be described by the composition close to a material of the L/LL type chondrites with the Fetot/Si weight ratios ranging from 0.9 to 1.3. Planetesimals composed of these types of ordinary chondrites could be considered as analogues of building material for the rock-iron cores of the Galilean satellites. Similarity of bulk composition of the rock-iron cores of the inner and outer satellites implies the absence of iron-silicon fractionation in the protojovian nebula.
Acknowledgements. This research was supported by the RFBR Grant 06-05-64308 and by Russian Academy of Sciences under Programs 9 and 18.

Keywords: europa, callisto, ocean

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS030 **Oral Presentation** **1564**

Effects of Silica Particles on the Flow Law of H2O Ice: Implication for Lobate Debris Aprons on Mars

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Topographic features related to ice-dust mixture are found on Mars. Particularly, lobate debris aprons have been interpreted as the result of viscous creep of ice-dust mixture. Thus, the flow properties of ice-dust mixture are important to study the formation process of such topographic features. Deformation experiments of ice-dust mixture have been conducted to clarify the mechanical strength depending on the dust content. However, these results are controversial, because they used the samples with different particle sizes, shapes, and internal structures etc. Therefore, we carried out deformation experiments of ice-silica mixture by changing the silica content with the same internal structure and the particle size to examine the flow law. We prepared the samples by mixing ice particles (0.3-1mm in the diameter) with glass beads (1micron in the diameter). The silica contents were 0-50wt.%. The samples were made by using two methods to have different internal structures. One was a frozen sample method (f.s.) that we mixed ice grains, glass beads, and water in a mold. Another was a pressure-sintering method (p.s.s.) that we compressed the mixture of ice grains and glass beads at about 50MPa. We conducted uniaxial compression tests under constant strain rates from 2.2x10^-6 to 2.9x10^-3[1/s] in a cold room at 263K. We examined the flow law (de/dt=AxS^n: de/dt is the strain rate, S is the maximum stress, and A and n are the flow parameters) of each sample with different silica contents and internal structures. As a result, we clarified that the flow law varied with the silica content and the internal structures systematically. Particularly, the value of n increased with the silica content : the value of n (f.s., 50wt.%) was twice as large as that of pure ice., and the value of n (p.s.s., 50wt.%) was 3.5 times larger than that of pure ice. We applied our results to the topographic models of lobate debris aprons on Mars proposed by Mangold and Allemand (2001). They calculated the topographic profiles of the debris aprons by using the flow law and compared their results with the observed profiles of MOLA. They calculated for pure ice with n=3 and n=infinite, that means perfectly plastic body, and concluded that the calculated profile of the perfectly plastic body was more consistent with the MOLA profile. Our new flow law containing the effects of silica particles concluded that the flow law with larger silica content was more consistent with the MOLA profile, and particularly, the calculated profile by using the flow law of the p.s.s. with the content of 50wt.% was very close to the MOLA profile.

Keywords: flow law, lobate debris aprons, ice silica mixture

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JMS030 **Oral Presentation** **1565**

Impact experiments on snow: the effect of sintering on the formation of crater

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Introduction: Recent planetary explorations for small bodies revealed that they have a large. These small bodies could be a mixture of silicates, ices. The important mechanism to give the strength in porous small bodies could be a sintering of the dusts. Sirono and Yamamoto (1997) studied the porosity evolution by sintering and the thermal history in small icy bodies for the implication to comets. They showed that the mechanical structure of the strength developed by sintering in the process of the thermal evolution. Therefore, we studied the contribution of sintering in controlling the mechanical strength of icy bodies and the effect of sintering on the formation of impact craters made on snow. Experimental method: Impact experiments on snow were conducted to make clear the formation mechanism of crater and the disruption mechanism of the sintered porous materials. The target was made of ice particles with the size of about 500 microns. The ice particles were put in a cylindrical container with the diameter of 13.5cm and the height of 10cm for the cratering experiments. The target porosity was in between 35 % to 45 % and the target was set in a cold room for sintering from 3 minutes to 16 hours. We used the projectile made of ice and snow with the porosity of about 30%. The projectile was a cylinder with the diameter of 7mm. The projectile was launched by a He-gas gun at the impact velocity less than 150 m/s. Every impact experiment was conducted in a large cold room at the temperature of -5 to 18C. Results: We have found that the crater size clearly increased with increasing the impact velocities at 10 deg. C. The snow projectile was recovered intact at low velocity impacts, but it was broken completely at high velocities and the relic of impact point was observed as ring-like structure. At lower temperatures, the crater size became larger at the same impact velocity. In contrast, the crater size became smaller at higher temperatures. The relationship between the crater volume (Vc) and the projectile kinetic energy (Ek) was fit by power law equations for each temperature and projectile. The power law index derived from the fitting for each data was about 0.5 irrespective of the temperatures. The Vc of the lower temperatures becomes larger at the same Ek because of the effect of sintering. The Vc at 18 deg. C is noted to be three times larger than that at 5 deg. C. We also found that the crater size simply decreased with time from 3min. to 6hrs. at 10 deg. C. Sirono and Yamamoto (1997) Planet. Space. Sci. 45, 827-834.

Keywords: impact cratering, planetary formation process, comets

(M) - IAMAS - *International Association of Meteorology and Atmospheric Sciences*

JMS030 **Oral Presentation** **1566**

Numerical Modelling of Cratering Processes and the Crust of Europa

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Europa with a diameter of 3122 km is one of the five larger moons of Jupiter. Its icy surface morphology is extremely smooth and is characterized by topographical variations on the order of a few hundred meters. Impact craters are sparse and amount to no more than three with diameters beyond 5 km. These surface characteristics, which somewhat resemble terrestrial sea ice regions have led to the hypothesis that Europas crust may be underlain by a water mantle. It is assumed that this water mantle has remained liquid because of the input of tidal dissipative energy despite sub-freezing temperatures at the surface. Based on considerations involving tidal heat energy dissipation and the fact that younger craters seem to be filled by frozen water, crustal thicknesses of 10 o 30 km have been estimated. In order to shed more light on the thickness of Europas crust, we carried out numerical impact cratering simulations. Due to the limited adaptability of commercial programs we decided early on to develop our own numerical code. The code (iSALE) enables Eulerian and Lagrangian computations and is partly based on the SALE code (Simplified Arbitrary Lagrangian Eulerian), which was developed at Los Alamos National Laboratory and its later extensively modified version SALEB (by Boris Ivanov). We further modified the code in order to account for the rheological, thermal and stratigraphic characteristics of Europas crust. Our numerical experiments simulated the impact of an icy body onto the crust of Europa, where we systematically varied the size and speed of the impactor as well as the thickness and the physical properties of the icy crust. This was aimed to derive plausible estimates of crustal thicknesses on Europa based on a comparison between modeled and observed crater morphologies. For those morphologies of the resulting crater structures that agree with observations, our results suggest that the icy crust has a thickness of app. 20 km and consists of a brittle outer layer and a more ductile lower layer comprising about 50 to 60% and 40 to 50% of the total thickness, respectively. The relatively large volume of impact melt generated partly filled the evolving crater structure and contributes to the morphological characteristics seen today.

Keywords: europa, cratering, modeling

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JMS030 **Oral Presentation** **1567**

Laboratory study of chemical processes on interstellar ice grains

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Chemical processes on interstellar dust grains play a key role in chemical evolution in space. For example, it has been widely accepted that hydrogen molecules are formed by H-H recombination on the surface of dust grains. Furthermore, observations have indicated that numbers of molecular species such as CO, CO2, and simple organic molecules are embedded in water ice mantles of interstellar dust grains. Most of these molecules can not be produced sufficiently in gas phase and require the chemical processes of ice mantles. Since reactions in ice mantles strongly depend on the structure and the composition of ice, theoretical approach to those is very difficult compared to gas-phase reactions. So, the experimental study is desirable to understand the chemical evolution in dust grains. We report the results of our recent experiments regarding the evolution of primordial CO molecule in ice mantle of grains via surface hydrogen atom reactions and photolysis of water ice containing CO which are dominant processes in interstellar molecular clouds. To evaluate the roles of photolysis and reactions of hydrogen atoms (hydrogenation) in the evolution of CO molecule under the various conditions of molecular clouds, we performed the experiments on the UV and H atom irradiation of the analogues of primordial ice mantle (H2O-CO binary ice) with several types of ice structure at various temperatures. The major difference in the results between photolysis and hydrogenation is the number of products. Photolysis yields CO2, HCOOH, H2CO, CH3OH, CH3CHO, and possibly undetectable small amount of other products, while only H2CO and CH3OH are obtained in hydrogenation. The main channel of photolysis is the production of CO2. The efficiency of H2CO and CH3OH formation (yields for 1 photon and 1 atom) and the total amount of those yields for the hydrogenation are higher than those for photolysis. Hydrogenation of CO was found to proceed via tunneling reaction and to be much more sensitive to ice temperature and structure than photolysis. The presence of water molecules makes the range of reactive temperature wider in hydrogenation. Considering the conditions of molecular clouds, we conclude that production of CO2 is owing to photolysis, while hydrogenation is responsible for H2CO and CH3OH. The results for simultaneous exposure to hydrogen atoms and UV photon reproduced the observed abundances of CO2, formic acid, formaldehyde and methanol fairly well.

Keywords: interstellar, ice, grain

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JMS030 **Oral Presentation** **1568**

North polar ice cap of Mars at varying obliquities, simulated with coupled ice and atmosphere models

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Mars is one of the terrestrial planets. It is surrounded by a thinatmosphere which constitutes to about 95% of CO2. Like Earth, Marsruns through periodic climate changes due slight orbit variationsduring time-spans of 103 to 106 years. This includes changes ineccentricity, the position of the perihelion and the inclination ofthe rotational axis, which modifies the solar insolation at thepoles. During the last 5 Ma, the obliquity of the axis shifted between15 deg. and 35 deg. and has now an angle of 25.2 deg. Two numericalmodels, a general circulation model of the atmosphere (PlanetSimulator Mars) and a polythermal ice sheet model (SICOPOLIS), havebeen coupled to simulate the climate system of Mars. Earlier resultsfrom these model suggest that at low obliquities ice may form atsub-arctic latitudes (Stenzel et al., 2007; Planet. Space Sci.,submitted). Here, we present the results from the spatially extendedice-sheet model. The experimental set-up includes three runs of theatmospheric part for each two years, of which only the second one isused, and subsequent runs of the ice part for 25 Ma. The initialconditions are provided as follows: While using the present polar icecaps in all three experiments, the obliquity of the rotational axis ofMars is set to 15 degrees, 25.2 degrees and 35 degrees in therespective experiments. At 15 degrees of obliquity glaciationdownwards to 70 degrees north takes place within the first 10 Ma.Given an unlimited amount of available water the ice cap grows evenfurther through extensive glacial flow until equilibrium is reached.In case of high obliquity, i.e. 35 degrees in our experimental set-up,the difference between precipitation and evaporation is negativesouthward of about 85 degrees north the ice-cap shrinks until glacialflow compensates for evaporation in the vicinity of the ice sheet. Thecap grows again and reaches 82 degrees north at the end of thesimulation after 25 Ma. At an obliquity of 25.2 degrees the ice sheetreaches equilibrium with its margin at 78 degrees north.

Keywords: mars, obliquity cycle, north polar cap

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JMS030 **Oral Presentation** **1569**

Radiation-induced defects and radical reactions in extraterrestrial ice

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The environment of the intense radiationandthe extremely low temperature in space producesvarious radiation-induced defects in substance. Thermal stability of radiation-induced radical species in solid H2O considering comets and ice satellites (Tsukamoto et al., 1993) or in solid CO2 considering polar caps of Mars at ambient temperatures (Hirai et al., 1994) were firstly studied for future dating of surface substance based on the accumulation of radicals. Lifetimes of various radicals such as OH or CH3 in H2O and CO2 matrices for the ambient temperature were investigated and possible dating ranges of 106-109 years were indicated at the ambient temperature of 30-50 K. Optical and thermal stimulations or tunneling effectscausereactions of such free radicals. It results inchemical evolution ofmolecules to complex forms. We have studied radiation effects on solid SO2,CO2H2Oas well as D2Oby electron spin resonance (ESR) and luminescence methods. UV photo-induced chemical reactions on gas absorbedice systems withCO, CH4 and NH3 were alsoinvestigated especially for amorphous ices, which with porous structure easily absorb many kinds of molecules. ESR spectra of HO2 trapped in solid CO2 were different between HO2 from gas phase and that in gamma-irradiated solid CO2. The reason is supposed that the sites of HO2 in CO2 lattice are different between them. The hyper fine interaction in gamma-irradiated solid CO2 is smaller due to the density of matrix. Thermal stability of trapped HO2 was same for both of them and giving the activation energy of 0.27 eV and the frequency factor of 5105 s-1. These values are consistent with both in ESR and TL research (Norizawa et al 2000). ESR studies of amorphous ice after UV irradiation also showed HO2 radical. It is well known that HO2 radical is a main product by radiation in amorphous ice at 77K but it is OH in hexagonal ice. This is supposed that OH radical is unstable in amorphous ice and easily decays to HO2 at 77K. UVirradiated amorphous ice absorbing CO was investigated to know the reactions with OH and HO2 in amorphous ice. As a result, production of HCO radical was observed. As the ratio of CO molecule to the amount of amorphous ice was increased, the producing rates of radicals HCO and HO2 were enhanced. The ratio of HCO relative to H2O in this experiment was as much as ca. 10-6 for the case of UV exposure of 100 minutes and the photon dose of 21018 cm-2.Most ofHCO?in interstellarwere observed in gaseous state but not insolid ice(Allamandora et al., 1999). UV-chemical reactions in amorphous iceare supposed as the source ofHCO?in interstellar space. Tsukamoto Y., Ikeya, M., Yamanaka C., Appl. Radiat. Isot. 44 221 (1993) Hirai, M., Ikeya M., Yamanaka C., Jpn. J. Appl. Phys. 33 L1453. (1994) Norizawa K., Hirai M., Ikeya M., Jpn. J. Appl. Phys. 39 6759. (2000) Allamandola et al, Space Sci. Rev., 90 219. (1999)

Keywords: amorphous ice, radiation induced radicals, electron spin resonance

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JMS030 **Oral Presentation** **1570**

Mars Express' MARSIS observations over the polar deposits of Mars

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The polar layered deposits of Mars are ice-rich, finely stratified materials that may provide information on the climate history of the planet. The Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) on the Mars Express orbiter returned first subsurface data from Mars. MARSIS is a multi-frequency synthetic aperture orbital sounding radar. In its subsurface modes, MARSIS operates in four frequency bands between 1.3 and 5.5 MHz with vertical resolutions of about 100 meters. In particular the radar signal easily penetrated the North Polar Layered Deposits (NPLD) and the South Polar Layered Deposits (SPLD) to their base, suggesting that the deposits must be nearly pure ice.The signals clearly penetrate deep into the deposits at all frequency bands. In most cases, a strong reflection is seen at a time delay consistent with the expected depth of the contact of the SPLD materials with the substrate, up to a depth of 3000 meters for the case of the SPLD maximum thickness.Between the first pulse (topography) and the basal reflection, signals with a lateral continuity of over 100 km are present and their presence is related to the different frequency used by MARSIS. All the polar observations of MARSIS show that the bulk composition of the Polar Deposits is mainly ice with a minor component of dust. The variation of dust component is responsible of discontinuities within the internal deposits that may generate subsurface reflections or even scattering phenomena. Marsis data taken over the layered deposits allow to map the base of the material and, using topographic data it is possible to study the three-dimensional shape of the martian icecaps to estimate their volume, and this will lead to a better estimate of the water inventory of the planet.

Keywords: mars, marsis, mars express

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JMS030 **Oral Presentation** **1571**

Mars Reconnaissance Orbiter SHARAD observations over the polar deposits of Mars

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SHARAD (SHAllow RADar) is the subsurface sounding radar provided by the Italian Space Agency (ASI) as a Facility Instrument to NASA's 2005 Mars Reconnaissance Orbiter (MRO) to map the shallow (first 1000 meters) Martian crust, operating at 20 MHz with a bandwidth of 10 MHz resulting in a vertical resolution of about 15 meters in free space. The pulse of electromagnetic energy transmitted by the antenna is first reflected back to the radar by the planetary surface, then, due to the long wavelengths employed, a significant fraction of the electromagnetic energy is transmitted into the crust and is propagated downward, where additional weaker echoes can be generated by subsurface discontinuities and returned back to the radar. Previous mission to Mars gave a good insight of the surface of the Martian polar deposits, albedo and compositional information have been brought by multi and hyper-spectral imagery and morhpology has been finely unraveled by the NASA/Mars Global Surveyors' Mars Orbiter Laser Altimeter (MOLA). In 2005 first data from the Mars' subsurface have been returned by Mars Express MARSIS that observed the basal reflections from the base of the polar deposits. SHARAD started to operate in November 2006 and, among all the data, both the martian Poles were observed. The much more higher vertical resolution (one order of magnitude) of SHARAD allowed to detect fine details that were invisible to MARSIS. Selected SHARAD data taken over the poles show three characteristic echoes: 1) first impulse copying the topography 2) quite sharp subsurface echoes 3) a more blurred, continuous subsurface echo. These three different signals are common to both the pole but differently organized, highlighting the different geologic context of the martian poles. The south polar signals show bright, dense sub-parallel echoes in the first 500 meters, then a less 'layered' unit until a blurred reflector comes to evidence, at a depth of about 2000 meters. Data taken over the south polar region do not show the dense sub-parallel echoes features but there are signals from more scattered, more equally distributed layers; the topographic signal and the blurred 'basal' signal resemble the ones from the north pole. SHARAD data place between the lower-resolution but higher penetration depth MARSIS and the surface observation of previous missions, and the comparison with other data allows both to support the interpretation and to verify previous findings. SHARAD observations are an extremely valuable set of data that will improve the knowledge of the polar caps of Mars, extending available data to the 3rd dimension downward, in a challenging new environment for planetary geophysical data processing and interpretation.

Keywords: mars, sharad, mars reconnaissance orbiter

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JMS030 **Oral Presentation** **1572**

Numerical simulation of the conductive ice deformation effects on the europan ICY crust

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Time dependent simulations of the evolution of the Europan icy crust will be presented. Two mathematical models will be compared; one based on thermodynamics and the dynamics of the convecting ice and the otherone including also the dynamics of the upper conducting ice layer. An estimate of the heat flux from the inner ocean will be provided. The treatment of the analogue on Antarctica will be discussed in view of the simulation of the appearance of subglacial basins.

Keywords: liquid solid phase transition, subglacial basin, numerical simulation

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JMS030 **Poster presentation** **1573**

Unfrozen water, frost, and ice at and in the upper surface of Mars

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Microscopic liquid layers of water can develop at grain and mineral surfaces at and in the surface of Mars. This is caused, at least temporarily, by adsorption of atmospheric water vapour at the low temperatures at the surface of Mars. The upper parts of these layers can freeze at temperatures far below the freezing point of bulk water (freezing point depression). A sandwich structure with layers of ice, liquid water layer and mineral surface can evolve around the grains of the surface soil. Results of thermodynamical modeling, as a) the thickness or number of mono-layers of the liquid water layer in dependence on the diurnal temperature variations, b) the freezing point depression temperatures of the unfrozen water, and c) the equilibrium content of liquid water in the surface soil are derived on the basis of a sandwich model with van der Waals interactions between the substrate and the water ice layer, and with a liquid water layer in between. These results are discussed with respect to the general presence and content of liquid-like water and water ice in the surface at mid- and low-latitudes of Mars, and specifically in view of direct frost observations of Viking 2 and MER Opportunity, and of fog observations by MarsExpress.

Keywords: mars, water, ice

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JMS030 **Poster presentation** **1574**

The early distribution of water in the pre-planetary disk of the solar system

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In-falling circum-protostellar disks evolve into pre-planetary disks on nearly circular Keplerian-type orbits. The dynamics in pre-planetary disks is governed by gravitation of the growing young star, by friction, and by angular momentum conservation. The evolution of mass distributions, temperatures and pressures, including the partial vapour pressure of water in the disk is numerically described for different disk models. It is shown that, as is well known, there forms a snow-line, which indicates the limiting inner radius for ice to stably exist in the pre-planetary disk. This border line can have extended outwards up to nearly Jovian distances. This result is of relevance for the sites of the origin of comets and other ice bodies. The thermo-physical conditions in the inner disk have triggered evaporation, re-condensation and re-solidification of iron, nickel, and silicon, and of other elements and compounds. It is shown that the friction driven outward drift of that thermally processed matter must have transported these agglomerations of refractory elements and compounds outwards to distances of about that of Saturn into the outer disk of originally volatile matter. This mixing region of volatiles, mainly water ice, and processed refractories can have extended to Saturnian distances. Therefore, comets and other ice bodies, which have had their origin inside of Saturn's orbit, may well show traces of that pre-processed matter, as it seems to be indicated by results of comet missions. Thus, there is an outer part of the planetary system, dominated by volatiles, a mixing region between Saturn and Jupiter, and the region of the terrestrial planets, which is dominated in mass by refractories. The inner disk with its later terrestrial planets, as Earth and Mars, must have received the volatiles, as water, in a later accretion phase by impacting comets and asteroidal bodies.

Keywords: ice, preplanetary disk

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JMS030 **Poster presentation** **1575**

Scenarios for the formation of Chasma Borealis, Mars

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An intriguing feature of the Martian polar caps is the presence of large chasms and smaller scarps/troughs which have no counterpart in terrestrial ice sheets. In this study, the focus is on Chasma Borealis, which cuts about 500 km into the western part of the north-polar cap. A possible explanation for its origin is a temporary heat source under the ice due to a tectono-thermal event or a volcanic eruption [see the discussions by Fishbaugh and Head (2002; J. Geophys. Res. 107, 5013) and Greve et al. (2004; Planet. Space Sci. 52, 775-787)]. This possibility will be explored by assuming a locally increased geothermal heat flux in the region of Chasma Borealis for a limited period of time in the past, and simulating the dynamic/thermodynamic response of the ice cap with the model SICOPOLIS (SImulation COde for POLythermal Ice Sheets). The questions to be investigated are (i) how much geothermal heat over which amount of time is required to form the chasm, (ii) how much water is discharged by a process of that kind (catastrophic flooding?), (iii) what are the local ice-flow velocities at the slopes of the chasm, and (iv) which processes can keep the chasm open after the end of the heating event.

Keywords: chasma borealis, polar cap, mars

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JMS030 **Poster presentation** **1576**

Thermoelastic effects in the icy shell during cryovolcanic eruptions on Enceladus

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Enceladus is one of Saturn's inner satellites and was discovered in 1789. In many ways, general properties of Enceladus are very different from those of other satellites, and thus it is an active research topic. With an albedo of 0.99, it has the most reflective surface of any body in the solar system. Furthermore, it is geologically active, i.e., cryovolcanism exists on Enceladus. Cryovolcanism is the low temperature counterpart of volcanism on Earth, in which liquid water takes the role of magma. On Enceladus, the eruptions take place in the south polar region. Water, coming from pressurized chambers between the icy surface and the rocky core of the moon, is erupted and renews the icy surface. Classical thermoelasticity is based on Fourier's law of heat conduction which leads to the well-known diffusive heat equation. Most applications are accurately described by this parabolic equation, but at cryogenic temperatures the material behaviour might differ greatly from that at room temperature. One of the properties that might change is the way heat propagates. Consequently, non-classical theories of thermoelasticity have experienced great interest during the recent decades. We apply the non-classical Green-Naghdi model as well as the classical Fourier model to Enceladus' icy shell. By using the Finite Element Method, the resulting thermoelastic field equations are solved numerically, and we study the propagation of thermoelastic waves as a result of cryovolcanic eruptions for both cases.

Keywords: cryovolcanism, thermoelasticity, enceladus

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